COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

PETROLEUM SEARCH SUBSIDY ACTS

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NORTH WINTON GRAVITY SURVEY, QUEENSLAND, 1959

BY

MAGELLAN PETROLEUM CORPORATION

Issued under the Authority of Senator the Hon. W. H. Spooner, Minister for National Development
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DEPARTMENT OF NATIONAL DEVELOPMENT

Minister: SENATOR THE HON. W. H. SPOONER, M.M.

Secretary: H. G. RAGGATT, C.B.E.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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FOREWORD.

In 1959 the Commonwealth Government enacted the Petroleum Search Subsidy Act 1959, under which companies proposing to drill for new stratigraphic information or to carry out either geophysical surveys or bore-hole surveys in the search for petroleum could be subsidised for the cost of drilling or of survey operations approved by the Minister for National Development.

The Bureau of Mineral Resources, Geology and Geophysics is required, on behalf of the Department of National Development, to examine the applications, maintain surveillance of the operations and in due course publish the results.

A gravity survey was carried out under the Petroleum Search Subsidy Act 1959 in the North Winton area of Queensland by Magellan Petroleum Corporation. This Publication deals with that survey and contains the information furnished by or on behalf of Magellan Petroleum Corporation and edited in the Geophysical Branch of the Bureau of Mineral Resources. The geological report and review of results was written by H.I. Harris, Chief Geologist, Magellan Petroleum Corporation, and the report on field procedures and interpretation of results was written by Karl W. Abel of Century Geophysical Corporation. The methods of carrying out the gravity survey and the results obtained are presented in detail.

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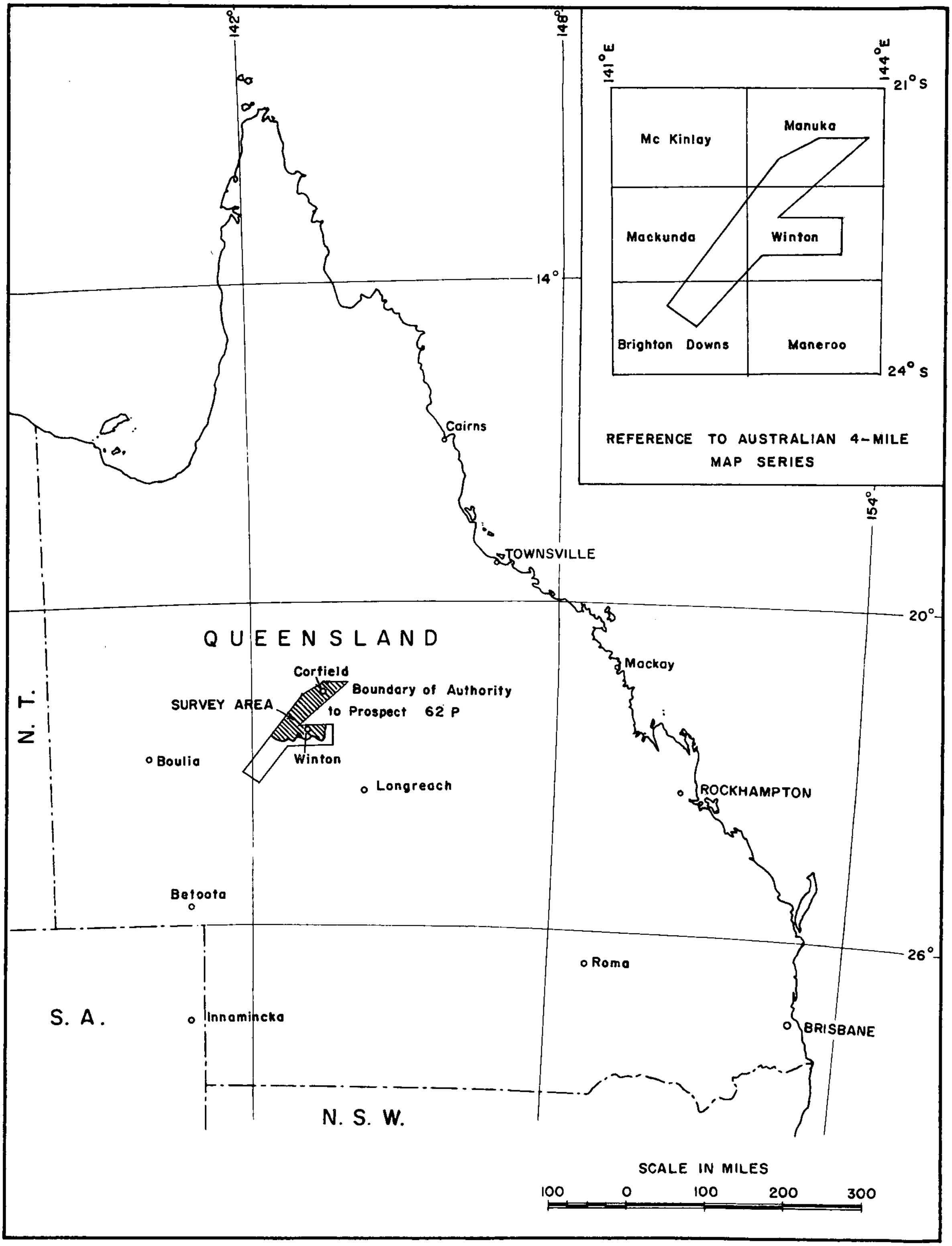

Fig. 1. LOCALITY MAP

ABSTRACT.

This report covers gravity survey work conducted by Century Geophysical Corporation for Magellan Petroleum Corporation during the period 1st July to 31st December 1959. The survey was made following an aeromagnetic survey.

The gravity survey was intended to corroborate the magnetic interpretation; to provide further information as regards depth to basement and fault systems; and to indicate structural "highs" which could then be more precisely delineated by seismic reflection methods.

Gravity values were observed and plotted over the area surrounding Winton, Queensland. Both the gravity survey and the aeromagnetic survey indicate a fault or fault zone across the area. In an appendix by the Bureau of Mineral Resources, it is stated that a seismic profile crossing this zone indicates that this zone is either a fault or a monoclinal fold.

Magellan Petroleum Corporation are planning to deepen the water bore at Corfield, and if this does not provide sufficient information regarding the deeper rocks, a further stratigraphic test will be drilled at Winton.

I. INTRODUCTION.

Magellan Petroleum Corporation, who were granted Authority to Prospect 62-P (see Figure 1) by the Queensland Department of Mines for a four-year term commencing 1st January 1959, engaged Century Geophysical Corporation, Jenkins Building, Tulsa, Oklahoma, U.S.A., to carry out a gravity survey over the greater part of the prospect. The town of Winton is situated in the southern part of the area surveyed. The survey took place between 1st July and 31st December 1959.

Prior to the gravity survey, there had been an aeromagnetic survey. The data from this survey were sent to Aero Service Corporation of Philadelphia, Pa., U.S.A. for interpretation. Plate 1 shows the aeromagnetic map derived from the basic data.

The only information available on the geology of the subsurface is from water bores which occur over a scattered area; the depths of these bores vary from 2000 to 4500 feet. This information was compiled by Magellan Petroleum Corporation and is shown (see Plate 2) as a contour map drawn on the "first significant" (i.e. the uppermost) aquifer of the Blythesdale Group. (1)

It was not possible to derive any definite conclusions from the known geological data regarding the structure of the area. It was therefore decided that a gravity survey on a semi-detailed basis should be made in order to delineate structural features of any size. The gravity survey was not expected to select positions where drilling for oil might prove successful but only to indicate areas or structures which should be investigated by the seismic reflection method.

Technical personnel employed by Century Geophysical Corporation for this survey were:-

Eugene P. Lane	-	Party Chief
Robert E. Brettell	-	Assistant Party Chief

Employees working for Magellan Petroleum Corporation but supervised by the Century Geophysical Corporation were:-

Colin Rush	-	Surveyor
David Worrall	-	Surveyor
Alfred Brosch	-	Meter Operator

The final interpretation (see Chapter VI) was carried out for Century Geophysical Corporation by Karl W. Abel. The geological report and review of results (see Chapter VII) were written by H.I. Harris, Chief Geologist, Magellan Petroleum Corporation.

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(1) Footnote by the Bureau of Mineral Resources.

Recent palaeontological evidence, especially from microfloral studies, has shown that the Transition "beds" of the Blythesdale Group are Cretaceous and the remaining units of the Group are Jurassic.

II. GEOLOGY.

Shales of the Winton Formation are exposed over most of the North Winton area. The Rolling Downs Group consists of three formations of Cretaceous age: the Winton Formation; the Tambo Formation; and the Roma Formation. Water bores were drilled through the formations of the Rolling Downs Group until the first aquifer, a sedimentary rock of the Blythesdale Group, was penetrated.

No information is available concerning the deeper rocks because water bores were not drilled below the artesian strata. The rocks underlying the artesian strata may be either (i) Cambro-Ordovician sedimentary rocks related to those outcropping in the Boulia area to the west or (ii) granite as at Longreach to the south-east or (iii) a clastic facies similar to those at Betoota and Innamincka to the south-south-west. Of these three areas, Longreach is the nearest geographically, but it does not necessarily follow that in the North Winton area the pre-Mesozoic rocks are granite.

The water bores indicate that the total thickness of the Rolling Downs Group increases southwards from about 2500 feet at the northern margin of the prospect to about 3500 feet at Winton. The map contours (see Plate 2) on the uppermost aquifer also indicate that there is a gentle sag of the Mesozoic rocks to the south. No faults or sharp flexures are known in any of the surface or near-surface rocks but the aeromagnetic interpretation (Plate 1) indicates an important fault system. This is probably an older feature which occurred before the Mesozoic sedimentation.

The gravity survey was intended to corroborate the magnetic interpretation; to provide further information as regards depths to basement and fault systems; and to indicate structural "highs" which could then be more precisely delineated by seismic reflection methods.

III. OPERATIONAL PROCEDURE.

For the gravity survey of the area, a general reconnaissance pattern was used. Nearly all the traverses were along roads, tracks, and fire breaks. The country is generally flat and open. It was readily accessible using four-wheel-drive equipment.

Two Watts theodolites were used at the beginning of the survey. After six weeks, it was decided that the theodolites were impracticable for the accuracy required. A Zeiss automatic level was equipped with a compass and used by one survey crew. The other crew continued to use the theodolite for horizontal control and a standard level for vertical control A second Zeiss automatic level was later purchased. These Zeiss levels approximately doubled the rate of surveying.

Very little time was lost due to bad weather. Continuous hot weather in November and December made it difficult to survey during the hottest part of the day. Consequently, the crew began work at 5.00 a.m. and took a siesta in the middle of the day.

A levelling accuracy of $0.3\sqrt{m}$ ft, where m is the length of the traverse in miles, was maintained throughout the survey. The misclosure in elevation was distributed along each traverse. Elevation datum was established from Department of the Interior bench marks. Elevations are on the State datum.

Astro-stations established by the Division of National Mapping were used for the horizontal control. An accuracy of $100\sqrt{m}$ ft, where m is the length of the traverse in miles was maintained throughout the survey. The positions of the 3300 gravity stations were fixed by magnetic bearings and stadia distances. Stations through 2650 were marked with a paper tag and all subsequent stations with aluminium tags.

Three new "World-Wide" gravity meters (serial numbers 28, 29, and 38) were employed during the course of the survey. The gravity meters were originally calibrated against each other prior to leaving the United States and the original base loops in the survey area were established with all meters, and this verified the relative calibration of the meters. After the completion of the survey, the meters were recalibrated on bases set up by the Bureau of Mineral Resources and the gravity survey tied to a pendulum station.

Base loops were run so that loop closures could be made. The drift of the gravity meter was distributed on a linear time scale, the meter normally being checked at base stations every two hours. The computations of the basic data were made in the field office in Winton and in Tulsa, Oklahoma. The gravity values are accurate to within 0.07 milligals.

IV. DENSITY DETERMINATIONS.

The gravity method is based on the measurement of small variations in the earth's gravitational field caused by lateral changes in mass distribution. In interpreting the gravity data, it is necessary to know the density of the various rocks.

No rock samples from the area were sent for density determinations. However, the following density determinations had already been made on samples from other parts of the Great Artesian Basin, including some from South Australia, and were available from information supplied by the Bureau of Mineral Resources, Geology and Geophysics.

Rock Densities in the Great Artesian Basin.

1. A.A.O. Wyabba No. 1 Bore, 1957.

Carpentaria Region, Northern Queensland.

Specimen No.	Type/formation	Depth (feet)	Density (g/c.c)
(i)	Grey shale, Tambo Formation(?)	1155 - 1156	1.93
(ii)	Carbonaceous grey shale, Tambo Formation	1692 - 1693	1.93
(iii)	Dark greyish mudstone, (shale), Roma Formation	2229 - 2230	2.12
(iv)	Greyish fine grained sandstone, Blythesdale Group	2634 - 2635	2.27

2. Haddon Downs Bore No. 1. 1958.

South-west Great Artesian Basin, South Australia.

Specimen No.	Type/formation	Depth (feet)	Density (g/c.c)
(v)	Soft greyish-greenish clay	400	1.92
(vi)	" " " "	443	1.76
(vii)	" " " "	463	1.82
(viii)	" " " "	511	1.80
(ix)	Grey-greenish sandy clay	533	1.83
(x)	as above, with carbonaceous plant remnants	553	1.67
(xi)	Soft grey-greenish clay	574	1.94

3. Density profile in vicinity of Haddon Downs Bore.

Formation composed of sandstone and shale with white and coloured siltstone	1.9
"Duricrust" layer, silicified shale	2.4

Nothing is known of the rocks below the Mesozoic rocks in the North Winton area; however it is reasonable to assume that the density of these rocks is greater than that of the Mesozoic rocks.

V. REDUCTION OF RESULTS.

Latitude corrections were determined from the formula based on the International Ellipsoid.

The Bouguer correction factor was 0.07 milligals per foot (mgal/ft) which corresponds to a rock density of 1.9 g/c.c. The elevation correction applied was a combination of the Bouguer correction and the free-air correction.

The gravity data were tied to the nearest pendulum station at Longreach. Plate 3 shows the Bouguer anomaly contours with the contour values in milligals, and the contour interval of 0.2 milligals. The boundaries of ATP 62-P, principal towns, and permanent gravity meter stations are also shown on the map. Local anomalous areas are designated by numbers for reference purposes.

The following basic information has been filed in the Bureau of Mineral Resources, Geology and Geophysics, and is available for future reference:-

(a) Gravity meter data sheets and drift curves.
(b) Locality plans of all base and permanent stations.
(c) Gravity base closure map.
(d) Elevation loop closure map.
(e) Tables of Principal Facts for all gravity stations relative to the Pendulum Station at Longreach.
(f) Bouguer Anomaly Contours on scale 1:48,000 (10 sheets).

VI. INTERPRETATION - by Karl W. Abel.

1. Introduction.

The basic assumption made in this interpretation is that the gravity maxima are indications of the uplift of land areas.(2) The lack of structural data for correlation with the gravity pattern, however, precludes any verification of this assumption. This fact should be borne in mind as structural information becomes available. The data and their computation will not change, but the interpretation of these data may change if other information is obtained which modifies the primary assumption.

The maximum anomalous areas are shown on Plate 3. Some of the anomalies may be composite effects of smaller structural features. It was considered more logical to show the larger maximum areas than to attempt to show the small individual components within each of these areas.

It was felt that only deep-seated anomalies which have a large area were worthy of consideration as prospects i.e. areas in which further investigation in the search for oil are justified. Consequently, a reconnaissance or regional survey was run in which some of the loops were as large as 4 x 7 miles. In general, this type of survey will detect anomalies which are the result of density contrasts at deeper levels or which cover a large area. Such large loops will not, however, delineate precisely the anomalous areas.

The fact that an anomaly covers a large area does not necessarily indicate a deep density contrast. In fact, one of the weaknesses of a survey involving large loops is the lack of resolving power with respect to individual, local anomalies. Thus, two or more anomalies having small areas may have a combined effect which simulates the effect of one anomaly having a large area.

One criterion of the depth of the density contrast from which an anomaly originates is the sharpness of the anomaly. Thus, small, sharp anomalies must necessarily be caused only by masses at shallow depth. Consequently, if anomalies originating at relatively shallow depths are to be discriminated against, small loops with a resultant high density of stations are dictated. These small loops would not aid in detecting any additional anomalies of large magnitude, but would permit the interpreter to discriminate against those anomalies whose sharpness indicates that they must necessarily be of shallow origin.

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(2) Footnote by the Bureau of Mineral Resources:

It should be pointed out that gravity anomalies arise also from other causes e.g. density contrasts in the basement and in the sedimentary rocks of the basin. These factors are referred to by the same author elsewhere in this Publication.

The limitations of the gravity method in defining subsurface structures have been described fully in an article by Skeels (1947) which indicates how widely different mass distribution can result in the same gravity anomaly. There is a need for other information aside from the gravity data to reduce the ambiguity which, at this stage, is inevitable in the interpretation.

A print of an aeromagnetic survey entitled "Base Map of Authority 62-P, Winton", was used as an aid in this interpretation (Plate 1).

Residual or derivative maps were not computed. The large loops result in a smoothing of the contours over the anomalies and tend, therefore, to make all anomalies appear to be of regional character. The separation of regional from local anomalies is an impossibility when there is no standard as to what constitutes regional and what constitutes local anomalies.

It is true that a residual map can be constructed from any contour map. The residual map will show closed contours in those areas in which the Bouguer anomaly map shows only noses and changes of gradient. These closures may have more meaning to a geologist and there may be a tendency to rely upon this map rather than the original Bouguer anomaly map from which the residual map was constructed. Also, the residual method does not discriminate between controlled and uncontrolled contours. Consequently, the computed map may indicate resolution not defined on the Bouguer anomaly map. The limitations of the residual method may be disregarded and much of the value of the survey may accordingly be lost. A second derivative map would be technically incorrect since it resolves anomalies of small area and consequently demands close spacing of the gravity stations.

2. Regional Features.

The western central part of the survey is dominated by a large area of minimum regional gravity. The southern and eastern central parts of the survey are dominated by a large area of maximum regional gravity. The division between the maximum and minimum areas in the southern and eastern central parts of the survey is an extremely steep gradient zone.

The steep gradient zone probably indicates a fault or fault zone with an upthrow to the east. The aeromagnetic survey indicates a fault with the same trend, but offset approximately three miles to the west from the position shown by the gravity survey.[3] It is difficult to

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(3) Footnote by the Bureau of Mineral Resources.

Upon critically examining the aeromagnetic map (Plate 1), it was found that not only is the projection used for the base map different from that used for the gravity data, but also the boundary of A.T.P. 62-P, the only feature common to both maps apart from geographical co-ordinates, is incorrectly plotted on the aeromagnetic map.

The "fault" interpreted from the magnetic data is oriented close to the magnetic meridian and therefore in a direction in which it is unlikely that the "fault" itself would give a magnetic anomaly. Its position seems to have been determined as the boundary between two areas, one in which the magnetic anomalies are relatively intense and one in which the anomalies are significantly less intense. There is no precise junction between these areas and hence the position of the "fault" is not determined precisely.

When these facts were taken into consideration it was evident that there is a reasonably close agreement in position between the "fault" as predicted from the gravity data and the aeromagnetic data respectively. The three mile "offset" mentioned by Karl W. Abel is reduced to approximately 1 1/2 miles.

rationalize an offset of this magnitude. The horizontal control as run for the gravity survey precludes any horizontal error that would appreciably affect the position of the fault as shown on the gravity map in relation to its position on the aeromagnetic map.

The regional minimum area on the western side of the fault is not completely defined. This area may be a graben if a comparable steep gradient zone exists west of the western boundary of the surveyed area. In any event, the basic assumption indicates that this area of minimum gravity is structurally low.

The regional maximum along the southern and eastern central parts of the survey is bounded on the west by the steep gradient which has been discussed earlier and is probably a fault. The eastern edge of the maximum area has not been defined. The rather gentle change in gradient occurring in the southern part of the prospect indicates relatively gentle regional dips.

The northern part of the survey indicates a reversal of the position of the maximum and minimum areas in that the north-east is fundamentally an area of minimum gravity and the north-west an area of maximum gravity. The dominant regional feature of the northern area is the minimum area which is bounded by steep gradients along the north-eastern, north-western, southern, and south-western flanks, and this also may be a graben.

The maximum area indicated by Local Prospects 5, 6, 7, and 8 coincides with a body of basic rocks as interpreted from the aeromagnetic data ("basic mass"). These anomalies may therefore be influenced by basement composition rather than density contrasts originating from structural movement. The same interpretation holds for Anomaly No. 3.

The steep gradient zone turns south-east in the north-central part of the area, suggesting that the fault zone turns nearly at right angles. Geologically, this seems improbable, but it is the best interpretation possible from the present gravity data.

3. Local Prospects.

The local anomalous areas are referred to as "Prospects" and have been designated by numbers for reference purposes and by the grades A, B, and C to designate the relative value of each anomaly, with A being the strongest grade. In addition to these anomalies there are other anomalous areas but of lower magnitude. At this stage of exploration of the area it is felt that only the more prominent anomalous areas should be defined. As mentioned previously, when additional geological data are available, a further study of the gravity results should be made.

Some of the anomalous areas are undoubtedly combinations of the over-lapping effect of smaller anomalies. Within the outline of some of the anomalies there are local gravity minima. However, because of the closeness of the possible separate anomalies, it is better to interpret each of the larger anomalous areas as a whole.

Prospect 1C possibly extends both to the north and to the south-east of the present outline. Detailed surveys may establish a definite change in gradient, but none is evident at present.

Prospect 2C and Prospect 3A combine to form a large maximum area. The two prospects have been separated because of the strong minimum entrant appearing on the eastern flank of Prospect 3A. No definite change in gradient has been mapped for Prospect 2C, but it may not be apparent for lack of detail. Prospect 3A is associated with a group of basic rocks as interpreted from the aeromagnetic data. It is bounded on its south-western flank by a steep gradient zone which is not delineated.

Prospect 4C is unusual in that it is located between two saddles in the gravity contours. It is, however, of approximately 10 units magnitude and therefore worth noting.

Prospects 5A, 6A, 7B, and 8A combine to form the larger maximum area along the north-western boundary of the surveyed area. As mentioned under "Regional Features" these individual maxima are in an area identified on the magnetic map as basic rocks, and, therefore may be caused by changes in the basement composition rather than by density contrasts resulting from structural movement. This association does not eliminate these maximum features as prospects for structural movement. Prospects 5A, 6A, and 8A are all excellent gravity prospects. Prospect 7B is somewhat weaker. A maximum trend running north-west from Prospect 7B may be of significance. Additional field work north-west of the boundary of A.T.P. 62-P would be required to evaluate it properly.

Prospects 9A, 10A, 11B, and 12B combine with Prospect 14B to form the northern half of the regional maximum area. Prospect 9A is the strongest of the local prospects. It is bounded by extremely steep gradients along its north-eastern and north-western flanks. This prospect could be the result of separate "highs" occurring within the boundary as outlined. Prospect 10A is represented by an excellent change in gradient. Its circular pattern indicates it is the result of a single anomalous feature. Prospect 11B is somewhat weaker than the two prospects referred to above and may extend east from the boundary which is shown on the gravity map. Prospect 12B is a good gravity prospect but lacks the magnitude of Prospects 9 and 10.

Prospect 13B is unique in that it lies within the regional minimum area. This prospect is located on the western side of the fault zone. Its position relative to the minimum area masks some of its magnitude.

Prospect 14B is undoubtedly a combination of two or more local anomalies. The most attractive area within the outline is along the north-western one-third of the anomaly. This is associated with the steep gradient zone.

Prospect 15C is an extremely difficult prospect to delineate.

Prospect 16A is the most attractive area covered on the survey. Small minimum areas are included within the outline of the anomalous area. The steep gradient along the western edge indicates faulting or extremely steep dip. The eastern edge indicates much gentler dips. Additional detail within the outline of the anomaly may resolve the individual "highs" that comprise this large maximum area. However, the resolution obtained with the present control is sufficient for the planning of a seismic programme.

Prospect 17C is of less magnitude than many of the other anomalies. It has, however, sufficient magnitude to be significant in terms of geological structure. It is closely related to Anomaly 16.

Prospect 18C is difficult to delineate. It could extend northward along the maximum nose to the permit boundary. Detail is needed north of the outline of the anomaly to determine if a gradient change occurs along the maximum nose.

Prospect 19C is also difficult to delineate. The broader anomaly is indicated rather than the several small maximum noses in the area.

4. Conclusions.

The regional pattern is dominated by the steep gradient zone which trends from north-east to south-west and indicates faulting.

There are some local anomalies which coincide with areas of basic rocks as indicated by the aeromagnetic data. Experience dictates that a positive approach should be maintained toward all anomalies.

The area covered by Prospect 16A is the most likely local area in which to start a seismic survey. After this survey, a critical re-interpretation of the gravity survey should be made. As mentioned previously, the basic data always remain valid, but the interpretation should be reviewed.

VII. DISCUSSION OF RESULTS - by H.I. Harris

In the preceding section Karl W. Abel has discussed the regional and local anomalies and has suggested areas which should be further investigated.

He concludes that one prospect, No. 16, which he considers as grade "A", would be one where a seismic reflection survey would be worthwhile. Other areas could possibly be upgraded following more detailed gravity work. He points out, also, that several of the gravity prospects coincide with areas of basic rocks as determined by interpretation of the aeromagnetic data. Although this situation would indicate that the gravity anomaly is probably due to a facies change in the basement and not to any structure in the sedimentary rocks, he states that "experience dictates that a positive approach should be maintained toward all anomalies".

A problem touched upon is the discrepancy in the location of the zone of major faulting as determined independently by the magnetic and gravity surveys. Karl W. Abel points out that the discrepancy of three miles could not be due to errors in horizontal control in the gravity survey. Admittedly, it is difficult to explain the offset.[4] However, of far greater importance, and not mentioned by Karl W. Abel is that the magnetics indicate that the upthrown block is to the west and not to the east as indicated by gravity. It thus appears that, before attempting to understand the details of the anomaly at No. 16, it is imperative to determine the true relation of the two major blocks which bound the fault system so far defined.

Should the gravity interpretation prove correct, it is possible that Anomaly No. 16 will prove to be a large closed structure although it may only consist of Mesozoic sedimentary rocks on a granitic basement. On the other hand, the magnetic interpretation indicates relatively thick strata underlying that area.

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(4) Footnote by the Bureau of Mineral Resources.

See footnote (3) on page 7

Such speculation is useful only in that it aids in selecting the next exploration tool. The Winton Shire Council has offered to allow Magellan Petroleum Corporation to deepen a water bore at Corfield.(5) This stratigraphic test is located about three miles south of the south-eastern edge of Anomaly 6A. This should provide more definite information, but should it prove inconclusive, a further stratigraphic test will be drilled at Winton in the area of Anomaly 17C.

VIII. REVIEW OF INTERPRETATION - by the Bureau of Mineral Resources

The interpretation of the gravity anomalies in a regional sense has been based on the assumptions that within a basin, regions of low gravity correspond to areas or troughs of thick sedimentary rocks and that regions of high gravity occur where the total thickness of sedimentary rocks is relatively small.

One of the dominant features of the gravity patterns is a zone of steep gravity gradients dividing the north-western and south-eastern parts of the area surveyed and which has been interpreted as being due to a fault or fault zone with an "upthrow to the east".

The minimum area to the north-west of the fault is considered to be "regionally low", possibly a graben. As H.I. Harris points out, this interpretation seems to be in direct contrast with the interpretation of the aeromagnetic data from which a fault is predicted in much the same position with a down-throw to the east. A possible explanation is that the difference is due to an error in the basic assumption that the regional gravity "lows" correspond to areas with thick sequences of sedimentary rocks. In general, the Mesozoic sedimentary rocks do not vary greatly in thickness throughout the Great Artesian Basin and any such variation could account for only a relatively small part of the total gravity changes observed. The regional gravity anomalies must arise mainly from differences in density and distribution of the rocks below the Mesozoic sequence.

In the south-eastern part of the Great Artesian Basin near Roma where the distribution of the rock types below the Mesozoic cover is better known than elsewhere, it was found (Dooley, 1950) that a region of low gravity corresponds approximately to one where bores have proved that Mesozoic sedimentary rocks rest on a granite basement.

On the other hand an increase in gravity towards Hutton Creek bore is almost certainly due to relatively dense Permian sedimentary rocks.

In contrast with the Roma area, it has been found that, by correlating seismic cross-sections and gravity data in the Quilpie-Charleville area, the regional gravity "lows" correspond closely to basins of pre-Mesozoic sedimentary rocks that are evidently less dense than the basement rocks on which they rest.

It was considered that the difference between the gravity and aeromagnetic interpretations in the North Winton area might be resolved if the density relations are similar to those in the Roma area. Clearly this difference, which is apparent also in the Tambo-Augathella area and may arise in other areas in the Great Artesian Basin, is of basic importance.

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(5) Footnote by the Bureau of Mineral Resources.

The bore at Corfield was completed on 15th June, 1960 and the report by Magellan Petroleum Corporation (P.S.S.A. Pub. No. 26) is in preparation.

In order to help resolve this difficulty the Bureau of Mineral Resources surveyed a continuous-reflection seismic traverse from a point approximately 15 miles north-west of Winton for 8 1/2 miles in a north-westerly direction along the Winton-Cloncurry road. The traverse crossed the zone of extremely steep gravity gradients which Karl W. Abel interprets as being probably due to a fault or fault zone with an up-throw to the east.

The results of the seismic profile suggest a fault or monoclinal fold in the Mesozoic sedimentary rocks near the minus 23-mgal contour with an up-throw of about 800 ft to the east. There is also a fault with an up-throw of about 400 ft to the east located between the minus 27- and minus 28-mgal contours and another fault with a throw of at least 500 ft in the opposite direction located between the minus 15- and minus 16-mgal contours. Reflections from below the Mesozoic rocks were poor but over the greater portion of the traverse, excluding the north-western end, a number of deep events were recorded that consistently indicated a steep north-westerly dip component. Towards the north-western end of the traverse deep events of better quality were recorded that indicated little or no dip component.

It is clear from the seismic results that variations in thickness of Mesozoic sedimentary rocks are insufficient to account for the observed change of 18-mgal in Bouguer gravity anomaly over the length of the seismic traverse, if it is assumed that the Mesozoic sedimentary rocks rest on granitic basement. However, if the deep seismic events are interpreted as reflections from pre-Mesozoic sedimentary rocks, the gravity gradient can be explained as being mostly due to a rapid increase in thickness of pre-Mesozoic sedimentary rocks from the south-eastern end of the traverse to the vicinity of the minus 27-mgal contour. It is not possible to make any estimate of the actual thickness of pre-Mesozoic sedimentary rocks from the seismic results, but the steep dips indicated suggest that the increase in thickness is quite large. Some of the sloping seismic events recorded from below the Mesozoic rocks may be diffractions from faulted reflectors rather than true reflections, but in any case an increase in thickness of pre-Mesozoic sedimentary rocks towards the north-west is indicated, whether due to folding or faulting.

The seismic results, although far from conclusive, support the gravity interpretation rather than the aeromagnetic one. They suggest the presence of a considerable thickness of pre-Mesozoic sedimentary rocks at least in the area tested. The area thus warrants consideration of further seismic investigation.

REFERENCES.

DOOLEY, J.C. 1950 Gravity and magnetic reconnaissance Roma district, Queensland. Bur. Min. Resour. Aust. Bull. 18

MAGELLAN PETROLEUM CORPORATION Magellan Corfield No. 1. P.S.S.A. Pub. No. 26 (In preparation).

MAGELLAN PETROLEUM CORPORATION Tambo - Augathella aeromagnetic and gravity surveys, Queensland, 1959. P.S.S.A. Pub. (In preparation).

SKEELS, D.C. 1947 Ambiguity in gravity interpretation. Geophysics 12 : 43-56

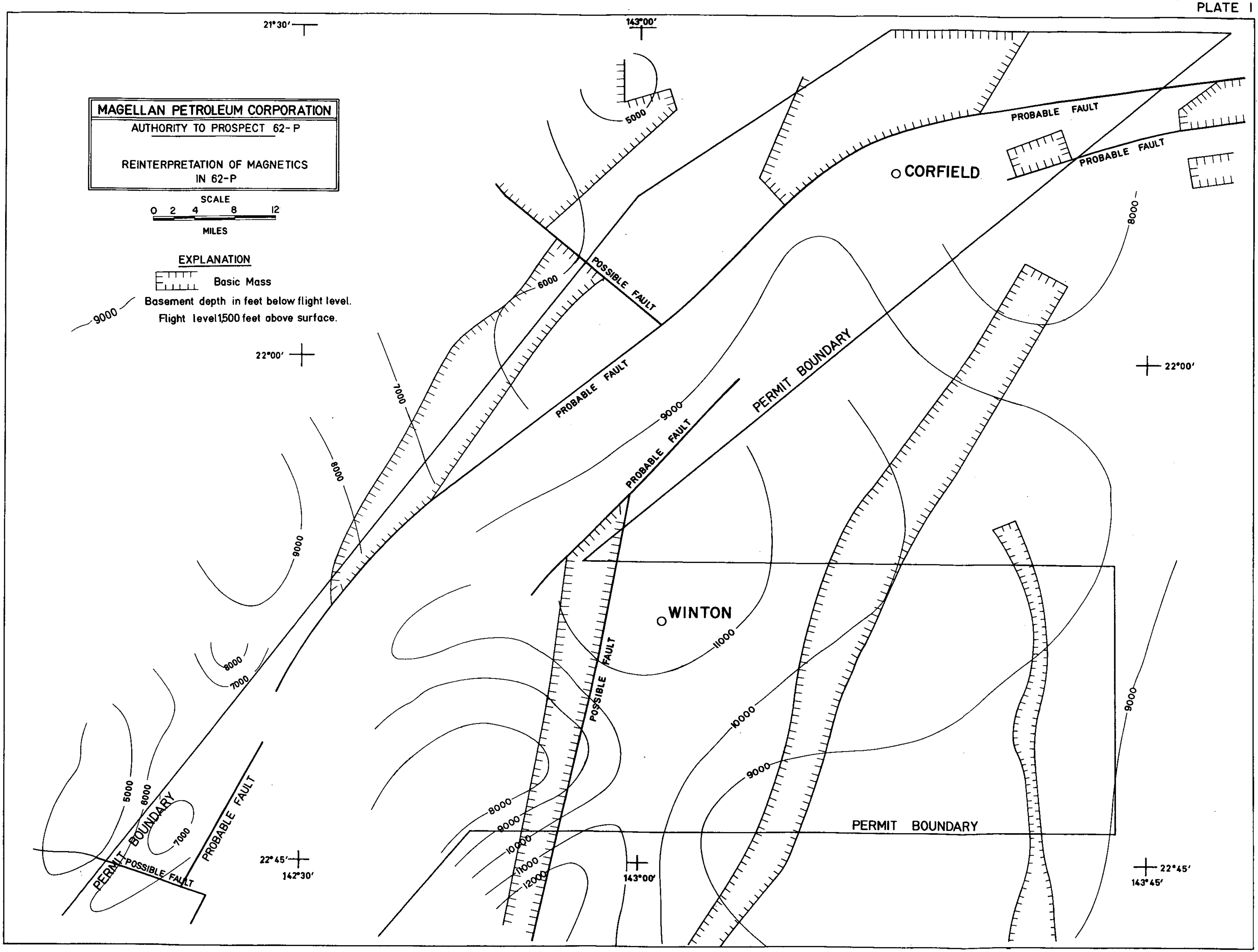

MAGELLAN PETROLEUM CORPORATION
AUTHORITY TO PROSPECT 62-P
REINTERPRETATION OF MAGNETICS IN 62-P
SCALE
0 2 4 8 12
MILES
EXPLANATION
Basic Mass
Basement depth in feet below flight level.
Flight level 1,500 feet above surface.
9000
21°30'
143°00'
22°00'
22°45'
142°30'
143°45'
CORFIELD
WINTON
PROBABLE FAULT
POSSIBLE FAULT
PERMIT BOUNDARY
5000
6000
7000
8000
9000
10000
11000
12000

PLATE 2

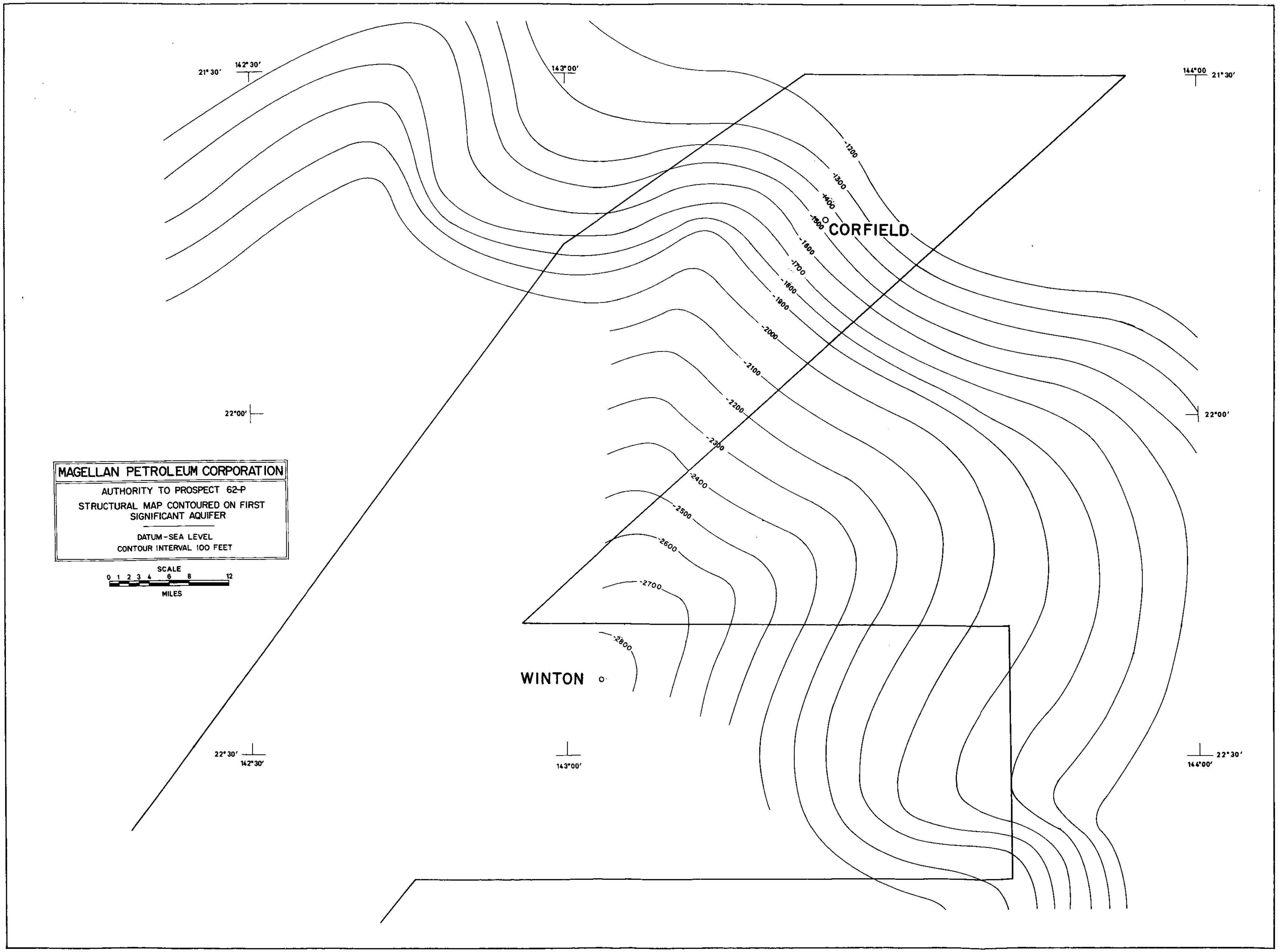
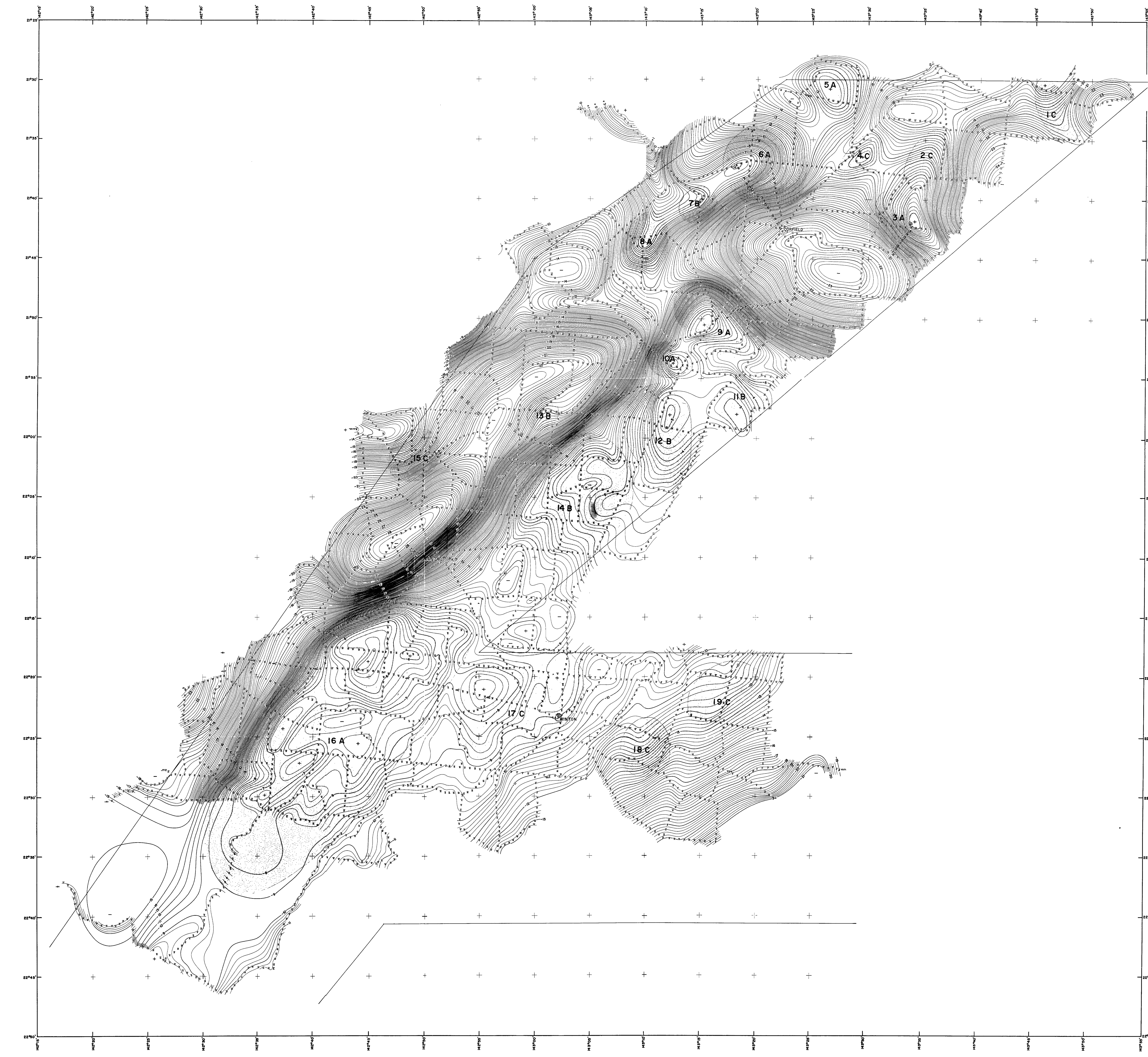

MAGELLAN PETROLEUM CORPORATION
AUTHORITY TO PROSPECT 62-P
STRUCTURAL MAP CONTOURED ON FIRST SIGNIFICANT AQUIFER
DATUM-SEA LEVEL
CONTOUR INTERVAL 100 FEET
SCALE
0 1 2 3 4 6 8 12
MILES
CORFIELD
WINTON
21°30′
142°30′
143°00′
144°00
21°30′
22°00′
22°00′
22°30′
142°30′
143°00′
22°30′
144°00′
-1200
-1300
-1400
-1500
-1600
-1700
-1800
-1900
-2000
-2100
-2200
-2300
-2400
-2500
-2600
-2700
-2800

PLATE 3



LEGEND

- ○ GRAVITY STATION
- -15.1 RELATIVE BOUGUER ANOMALY
- 110 STATION NUMBER
- PERMANENT STATION
- BASE STATION
- ▲ ASTRONOMICAL STATION
- + GRAVITY HIGH ANOMALY
- — GRAVITY LOW ANOMALY

MAP DATA

PROJECTION: TRANSVERSE MERCATOR

CONTROL: STATE AND NATIONAL MAPPING ASTRONOMICAL STATIONS DEPARTMENT OF THE INTERIOR AND STATE BENCH MARKS

DETAIL: GRID AND GRATICULE COMPUTED AND COMPILED BY CENTURY GEOPHYSICAL CORP. FIELD OFFICE GRAVITY STATION LOCATIONS PLOTTED FROM STADIA DISTANCES, AND MAGNETIC BEARINGS
HORIZONTAL ACCURACY: 100 FT $\times\sqrt{m}$ (m = LENGTH OF TRAVERSE IN MILES)
LEVELING ACCURACY: 0.3 FT. $\times\sqrt{m}$ (m = LENGTH OF TRAVERSE IN MILES)

ELEVATION DATUM: M. S. L. (QUEENSLAND STATE DATUM), DATUM ESTABLISHED FROM DEPARTMENT OF THE INTERIOR BENCH MARKS AND ELEVATIONS ESTABLISHED WITH RESPECT TO STATE DATUM. MISTIES PRORATED ALONG TRAVERSE

RESPONSIBILITY

GEOLOGICAL REPORT ---------- H. I. HARRIS
INTERPRETATION AND FINAL REPORT ---------- KARL ABEL
FIELD WORK, COMPUTING AND MAPPING ---------- E. P. LANE

EXPLANATION

RELATIVE BOUGUER ANOMALIES ARE BASED ON THE VALUES OF THE FOLLOWING B.M.R. STATIONS:
PENDULUM STATION NO. 54 - LONGREACH QLD. - 978,789.80 MILLIGALS
GRAVITY STATION NO. 57-4 - 971,710.75 MILLIGALS

AN AVERAGE DENSITY OF 1.9 HAS BEEN ASSUMED FOR ROCKS BETWEEN STATION SITE AND SEA LEVEL IN REDUCTION OF GRAVITY VALUES.

BOUGUER ANOMALY GRAVITY METER SURVEY

AUTHORITY 62·P (NORTH WINTON)
AUSTRALIA
FOR
MAGELLAN PETROLEUM CORP.

CONTOUR INT. = 0.20 MGL. ELEV. FACTOR = 0.070 SCALE 1:253,440

GEOPHYSICAL CORPORATION
TULSA, OKLAHOMA
AUGUST, 1960