GRAVITY METER SURVEY

O.P. 43

ALICE SPRINGS AREA
Northern Territory, Australia

1961

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O. P. 43

ALICE SPRINGS AREA
Northern Territory, Australia

for

MAGELLAN PETROLEUM CORPORATION

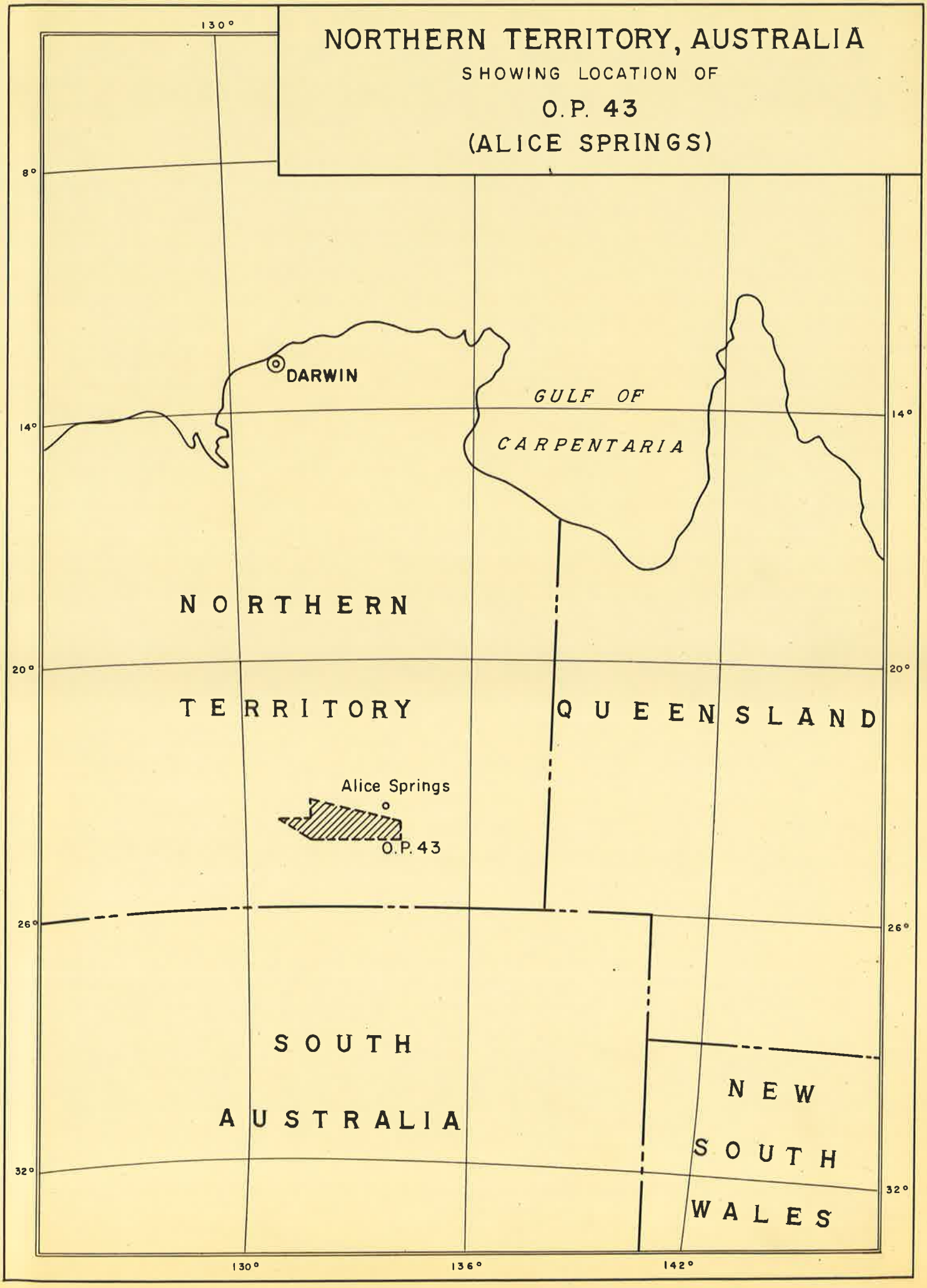
By:
Century Geophysical Corp.
Tulsa, Oklahoma

NORTHERN TERRITORY, AUSTRALIA

SHOWING LOCATION OF

O.P. 43

(ALICE SPRINGS)



TECHNICAL DATA

FIELD HEADQUARTERS: Alice Springs, Northern Territory, Australia

DATE OF SURVEY: January through July, 1961

BASE MAP: Quadrangles on a scale of 1" = 1 mi. with a 5' longitude and 5' latitude grid network were constructed. Prints on this scale are included with this report. The quadrangles were reduced to a scale of 1" = 8 mi. and prints from this reduction are also included.

INSTRUMENTS: Worden gravity meter #404 with a meter constant of .09624, Worden gravity meter #468 with a meter constant of .08586 and Worden gravity meter #368 with a meter constant of .09851 were used during the course of the survey.

ELEVATION FACTOR: 0.068 milligals per foot.

GRAVITY VALUES: Recorded above station locations in milligals.

CONTOUR INTERVAL: 0.5 milligals.

INTRODUCTION

The gravitational method is based on the measurement of small variations in the earth's gravitational field. These variations are caused by lateral variations in mass distribution which, in turn, are often the result of geological movements involving rocks of varying densities.

The unit of measurement used throughout this report is the milligal. A milligal is equivalent to approximately one millionth of the earth's normal gravity.

FIELD PROCEDURES

The personnel unloaded equipment, set up office and serviced vehicles and equipment on December 27th and 28th, 1960. Field work on the survey began on December 29th, 1960.

A control line of stations was run south from Alice Springs and north along the Hugh River, looping back to Alice Springs. Another profile line was run along the Finke River and a third in the Gosse's Bluff area. Elevation datum was established from M. S. L. Queensland State Datum established by the Dept. of Interior. Horizontal control was established from the National Mapping Astronomical and Trigonometrical stations. Trigonometrical stations were adjusted to astronomical datum by slotted template method determined by the Division of National Mapping. All lines were tied in closed loops or were double run.

This survey consists of 1281 stations, each of which is marked in the field with a 2" x 4" aluminum tag. Permanent stations, which were set approximately 8 miles apart, were marked with iron bolts 24" long driven in the ground approximately 18" or placed on a main road bench mark. These permanent stations are indicated on the attached print.

The gravity meters were calibrated on BMR stations in Brisbane. The relative gravity values are based on the observed gravity value at BMR pendulum

station #35 at Alice Springs.

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 both in the field office in Alice Springs and in Tulsa, Oklahoma.

The elevation correction applied is a combination of Bouguer and free air effect. Since both of these corrections are simple constants which are multiplied by elevation differences, they can be combined into a single constant. The elevation correction is 0.068 mgls. per foot which represents a density of 2.1 g/cm^3.

The latitude correction is applied because the acceleration of gravity is less at the equator than at the poles. This is a result of the surface being farther from the center of mass at the equator, which makes the attraction smaller; and because the centrifugal acceleration, which is opposite to gravitational acceleration, is greater at the equator.

INTERPRETATION

During the planning stage of the gravity survey a reconnaissance gravity map, G292-5 by the Geophysical Section, Bureau of Mineral Resources, Geology and Geophysics, was available. This indicated a regional minimum extending from Alice Springs to Gosse's Bluff.

A report on a detailed survey of Gosse's Bluff was also available. It indicated that the Gosse's Bluff structure is a shallow salt dome, but a review of the report left some doubt as to the presence of salt or any very low density stratum. This doubt has not been dispelled or verified after a number of structural features have been crossed by gravity lines in the present survey. Originally it was thought that the series of profile lines would reveal closely the relationship between structural features and gravity maxima or minima, but this has not been determined.

Near the conclusion of the field work three density profiles were run, one each over terrain of the Pertnjara, Arumbera and Bitter Springs formations. The Pertnjara profile indicates an elevation factor of 0.062 milligals per foot, or a density of 2.51 grams per cubic centimeter. Only station #10 of the profile fails to give agreement with these figures.

The profile on the Arumbera formation gives an elevation factor of 0.065 or 0.066, and a density of 2.28 or 2.20. The terrain over this profile was not as uneven as desirable for best results, so the results are not completely conclusive.

The profile on the Bitter Springs formation indicates an elevation factor of 0.068 or 0.070, and a density of 2.04 or 1.89. This is contradicted by station #9, which was bad for all elevation factors, and #6, which indicated a factor of 0.064. However, the elevation breaks at stations 1, 2, 3 and 4 give the straightest lines for factors of 0.068 or 0.070. The variations throughout the length of the profile may indicate lateral density changes throughout the formation.

These density profiles indicate that the normal increase in density with depth is reversed so that the Bitter Springs gives us the lowest density and the largest elevation factor. There is also the complication in that, although there is insufficient data from the density profiles to clearly indicate the point, the possibility of varying densities within the formation exists. This then presents the problem of a lithological change producing marked density contrasts unrelated to structural features. A further complication is that the amount of erosion and/or uplift may be critical in the decision as to whether gravity maxima or minima represent structural highs.

At the conclusion of the survey a series of profiles was constructed to be used in conjunction with the map presentation. The solid line on each of the profiles indicates the Bouguer anomaly profile and the dashed line indicates the residual anomaly profile. The absolute maximum or minimum value of the

residual profile is not critical. Consequently, the greatest value of the residual profile is to establish a high or low with respect to adjacent points.

The two areas on which sufficient detail was run to delineate the type anomaly associated with the structural feature are the Ooramina Anticline and the Waterhouse Range Anticline. The Waterhouse Range results in a prominent gravity maximum and the Ooramina Anticline results in a pronounced gravity minimum lying between two maxima.

LOCAL FEATURES

Profile A-A' lies along the line of stations in the vicinity of Gosse's Bluff. The extreme southern end of the profile indicates the sudden change in gradient which coincides with the Katanga Gap Fault. The maximum associated with the upthrown side of the fault indicates an increase of density with depth. The Bitter Springs does not produce the gravity minimum one would expect as the result of the gravity profile crossing the low density material. This may be due to the lack of total mass associated with the thin section of Bitter Springs.

The remainder of this profile indicates low magnitude maxima and minima in an area covered by recent sand deposits which conceal any structural evidence.

The contouring in the vicinity of Gosse's Bluff is copied from Frome's Bouguer map of that area.

Profile B-B' is north of Gosse's Bluff and indicates very rapid changes in density. This profile is typical of that associated with steeply dipping beds with marked density contrasts.

Profile C-C' lies along the Finke River. The south end of the profile indicates some abrupt density changes. However, a local maximum feature coincides with an un-named anticline near station #722. The Wild Eagle Syncline lies on a prominent local minimum. This is much more apparent on the

residual profile than on the Bouguer anomaly profile. The James Range "A" anticline lies on a broad maximum feature of considerable magnitude. The very apex of this structure is interrupted by a gravity minimum. This minimum falls directly along the line of Hugh River shale. This line of stations is along the river and, although there is undoubtedly terrain effect associated with these stations, it is doubtful that the minimum could be overcome by the addition of terrain corrections. The over all anomaly associated with the James Range "A" Anticline is a maximum feature.

Profile D-D' lies in the Hermannsburg Mission Area and crosses the axis of the Missionary Plains Syncline. This synclinal axis is associated with a maximum gravity feature. This then could be indicating a change in the density of the formation rather than evidence of a structural feature. Quoting from a letter from Duncan A. McNaughton, dated Oct. 3, 1961, "This change is probably related to the density of the near surface rocks - the Pertnjara is comparatively light in the south whereas the Pertnjara is comparatively heavy in the north where the conglomeratic facies becomes dominant towards the Macdonnell front."

Profile E-E' is along the Hugh River. The James Range "C" Anticline falls between stations #114 and #115. This is a prominent local maximum. The contouring along the line of the profile is not representative of that at stations #114 and #115.

The line of strike of the James Range "B" Anticline has been indicated since it coincides with a prominent local maximum feature. There was no coverage directly over the axis of this anticline. The Waterhouse Range falls on a prominent local maximum feature.

Profile F-F' crosses the Ooramina Anticline. The axis of this anticline falls on a prominent gravity minimum, flanked by local maxima. The configuration and character of this anomaly is typical of that of a structural uplift controlled by a low density material such as salt. Immediately northwest of the

Ooramina Anticline is a comparable gravity minimum centering near station #943.

Herb's Zilch structure lies on the extreme western edge of the survey. The eastern boundary on the structure as given on the aerial photo passes between stations #1210 and #1211. This structural feature lies on a prominent minimum which has not been defined. The present amount of work indicates that the gravity on this structural feature is controlled by a low density stratum.

CONCLUSIONS

The profiles along the Hugh River and Finke River indicate gravity maxima associated with the James Range "A" Anticline, James Range "B" Anticline, James Range "C" Anticline and the Waterhouse Range, and a prominent local minimum associated with the Wild Eagle Syncline. This correlation indicates the normal increase in density with depth.

The extreme eastern edge of the survey indicates a gravity minimum associated with the Ooramina Anticline and the extreme western edge of the survey indicates a possible minimum feature associated with Herb's Zilch structure. One possible cause of this change in character of the controlling density contrast is a change in the lithology of the low density stratum which the density profiles indicate to be the Bitter Springs formation. If a constant density of the Bitter Springs is assumed, the change from maximum to minimum controlling the evidence of structural uplifts may be due to the depth of burial to this low density formation. Since the basic gravitational law states that the attraction between two forces is inversely proportional to the square of the distance between these two masses, it is readily apparent that as the depth of burial of this low density stratum decreases, its effect will become a great deal stronger.

Because of the limited coverage by the profile lines, no specific anomalous areas outside of those associated with structural features have been indicated on the attached prints.

CENTURY GEOPHYSICAL CORP.

Interpretation by:

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Approved: