COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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PUBLICATION No. 69

SUMMARY OF DATA AND RESULTS

GREAT ARTESIAN BASIN, QUEENSLAND AND SOUTH AUSTRALIA

Innamincka-Betoota Aeromagnetic Survey

Oodnadatta Aeromagnetic Survey

OF

DELHI AUSTRALIAN PETROLEUM LTD

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DEPARTMENT OF NATIONAL DEVELOPMENT

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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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FOREWORD

Under the Petroleum Search Subsidy Act 1959, agreements relating to subsidized operations provided that the information obtained may be published by the Commonwealth Government twelve months after the completion of field work.

The growth of the exploration effort has greatly increased the number of subsidized projects and this increase has led to delays in publishing the results of operations.

The detailed results of subsidized operations may be examined at the office of the Bureau of Mineral Resources in Canberra (after the agreed period) and copies of the reports may be purchased.

In order to make the main results of operations available early, short summaries are being prepared for publication. These will be grouped by area and date of completion as far as practicable. Drilling projects and geophysical projects will be grouped separately. In due course, full reports will be published concerning those operations which have produced the more important new data.

This Publication contains summaries of data and results of two geophysical operations undertaken in the Great Artesian Basin, Queensland and South Australia: Innamincka-Betoota Aeromagnetic Survey, and Oodnadatta Aeromagnetic Survey. The information has been abstracted by the Petroleum Exploration Branch of the Bureau of Mineral Resources from final reports furnished by Delhi Australian Petroleum Ltd.

J.M. RAYNER
DIRECTOR

CONTENTS

ILLUSTRATIONS

FIGURES

PLATES

INNAMINCKA-BETOOTA AEROMAGNETIC SURVEY

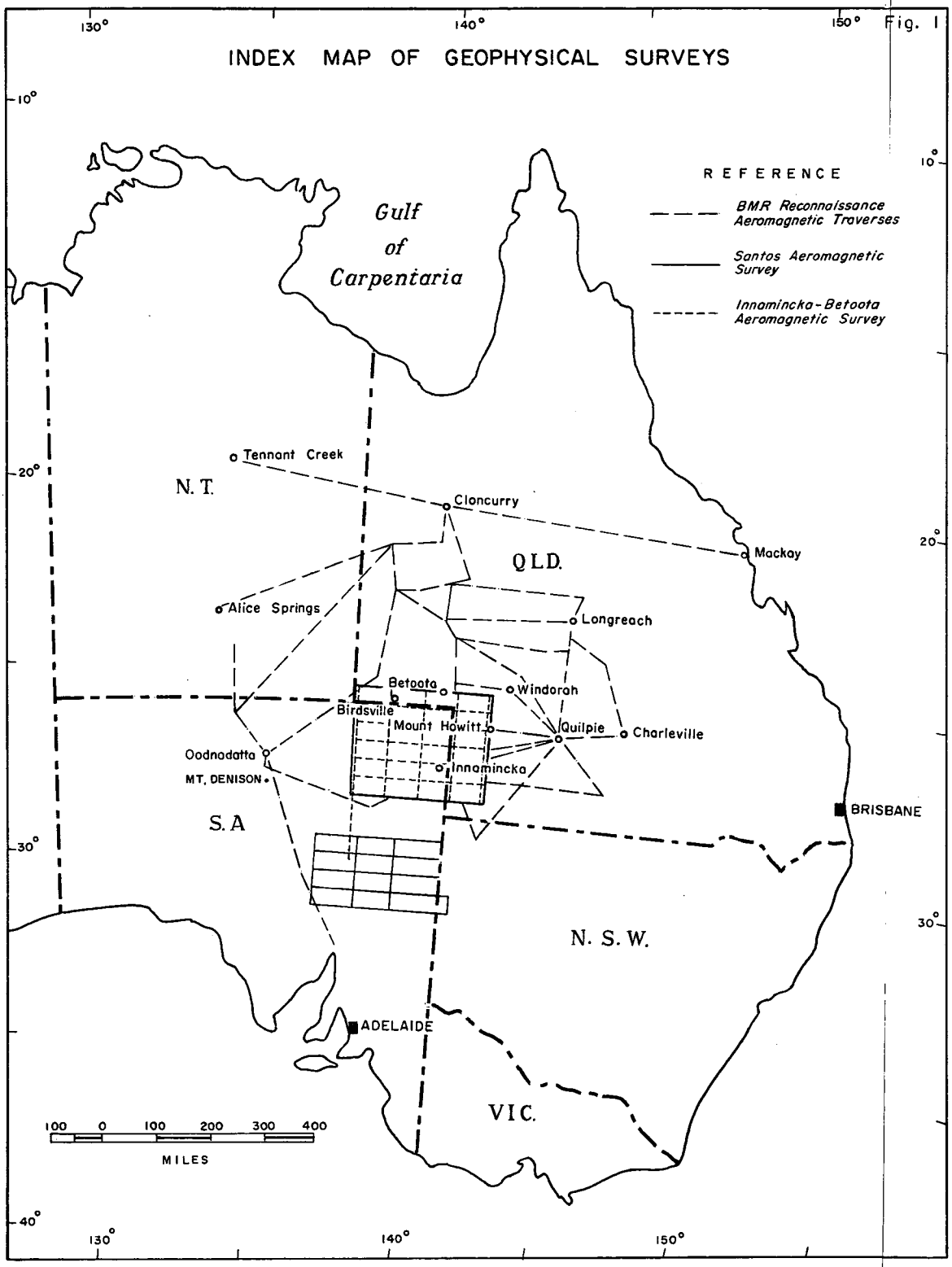
by

DELHI AUSTRALIAN PETROLEUM LTD

SUMMARY OF DATA AND RESULTS

Fig. 1

INDEX MAP OF GEOPHYSICAL SURVEYS



INNAMINCKA-BETOOTA AEROMAGNETIC SURVEY

SUMMARY OF DATA AND RESULTS*

SUMMARY

A reconnaissance aeromagnetic survey was conducted in 1961 by Aero Service (Bahamas) Ltd for Delhi Australian Petroleum Ltd. The survey covered a part of the Great Artesian Basin in the north-eastern corner of South Australia and adjacent areas in Queensland (see Fig. 1). The project area lies within Oil Exploration Licences Nos 20 and 21 (South Australia) and Authorities to Prospect Nos 66P and 67P (Queensland).

The survey was carried out using a Gulf Research and Development Company Mark III total field magnetometer of the self-orienting saturable core fluxgate type mounted in a tail boom installation on a Piper Apache aircraft. Navigation was by visual reference to 1:63,360 and 1:253,440 scale uncontrolled photo-mosaics and the actual flight path was recorded by an Aeropath 35 mm continuous strip film camera. A Gulf Research and Development Company storm monitor magnetometer was operated on the ground so that aeromagnetic data recorded during magnetic storms could be discarded. The data obtained during the survey were compiled and interpreted in the Philadelphia, Pa., office of Aero Service Corporation.

The purpose of the survey was to determine the depth and configuration of the basin within the survey area and to infer structural conditions at the basement surface which, if reflected in the overlying sedimentary section, could provide conditions favourable for the accumulation of oil or gas.

Flying commenced on 1st April and was completed on 8th May, 1961. A total of 13,777 line-miles of traverses and tie lines was flown at a barometric altitude of 1500 feet above sea level.

Traverses were oriented east-west at intervals of five miles, and tie lines were flown north-south across the survey area at intervals of twenty miles. The westernmost tie line was extended southwards from the southern boundary of the survey area for a distance of approximately 125 miles into the area of a previous reconnaissance survey carried out for Santos Limited. This survey consisted of approximately 2000 line-miles of traverse in the Lake Torrens area of South Australia. The traverses were arranged in a rectangular grid pattern consisting of five east-west lines at 35-mile intervals which were crossed by six north-south tie lines. The flight altitude was maintained at 1500 feet above sea level except in the south-central part of the area where it was increased to 4000 feet barometric elevation above sea level.

A set of fourteen reconnaissance aeromagnetic traverses totalling 8721 line-miles had been flown previously by the Bureau of Mineral Resources across the Great Artesian Basin during 1958. Portions of several of these traverses cross the main survey area, but the majority are located in the peripheral areas. The flight altitude was maintained at 1500 feet above ground level.

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* Abstracted from: Final Report-Interpretation of Airborne Magnetometer Surveys in South Australia and Queensland, for Delhi Australian Petroleum Ltd, by K.N. Isaacs and C.E. Curtis, Aero Service Corporation, August, 1961.

The results of these three sets of reconnaissance profiles, totalling approximately 10,800 line-miles, were analysed by Aero Service Corporation to provide additional information on the basin in and around the survey area.

Aeromagnetic data resulting from the Innamincka-Betoota survey indicated the presence of a large basin, subdivided by a saddle of possibly regional proportions. The two resulting sub-basins are located in the north-western and south-central parts of the survey area. Faulting appears to be associated with both the sub-basins. The depth of the magnetic horizon giving rise to the anomalies appears to be approximately 18,000 feet below sea level in both sub-basins.

Several relatively strong anomalies were detected in the east-central part of the survey area. Two of these appear to correlate closely with seismic "highs", indicating that relief in the magnetic basement may be associated with structure in the overlying sediments. Other features of interest are the deep fault lying along the southern boundary of the north-western sub-basin, the saddle separating the sub-basins, and a possible basement structure in the extreme south-eastern corner of the survey area. Computed sedimentary thicknesses in the project area range from 4000 feet to 21,500 feet.

The interpretation of the profiles flown by the Bureau of Mineral Resources within the main survey area is in general agreement with the interpretation of the aeromagnetic data from the subject survey. The interpretation of the Bureau profiles outside the main survey area, the Santos Limited profiles, and the southward extension of Tie Line 1, indicates that the depth to the magnetic horizon becomes shallower to the north, north-west, and south of the main survey area, but remains of the same order to the east.

After submitting the interpretation report on the Innamincka-Betoota survey and the reconnaissance profiles, Aero Service Corporation submitted to Delhi Australian Petroleum Ltd a Second Vertical Derivative Map of the total magnetic field intensity in the main survey area, together with an interpretation report on the second vertical derivative anomalies. The computation of the second vertical derivative map delineated more clearly small amplitude anomalies of the type which may be associated with basement relief and sedimentary structures. Thirty-nine such anomalies were delineated on the second vertical derivative map.

The geophysical operation undertaken in the Innamincka-Betoota area of the Great Artesian Basin, South Australia and Queensland, was subsidized under the Petroleum Search Subsidy Act 1959.

METHODS OF OPERATION

General Data

Operator:	Delhi Australian Petroleum Ltd, 32 Grenfell Street, Adelaide, South Australia
Contractor:	Aero Service (Bahamas) Ltd, Division of : Aero Service Corporation, Philadelphia, Pa., U.S.A.
Location:	North-eastern South Australia and the adjacent areas of Queensland. Project area bounded by latitudes 25°30'S and 28°30'S, and longitudes 138°00'E and 142°20'E.
Petroleum Tenements:	Oil Exploration Licences Nos 20 and 21, issued by the State of South Australia, and Authorities to Prospect Nos 66P and 67P, issued by the State of Queensland
Tenement Holders:	Delhi Australian Petroleum Ltd and Santos Limited
Basin:	Great Artesian

Field Operations

Date survey commenced:	1st April, 1961
Date survey completed:	8th May, 1961
Total survey mileage:	13,777 line-miles
Operational Bases:	Windorah, Mount Howitt, Innamincka, Birdsville
Aircraft:	Piper Apache VH-MJL
Magnetometer:	Gulf Research and Development Company Mark III total field magnetometer
Recording sensitivity:	600 gammas full scale deflection on 10-inch paper chart roll
Diurnal control:	Gulf Research and Development Company magnetic storm monitor, continuously recording total magnetic field intensity
Traverse direction:	East-West
Traverse spacing:	Five miles

Tie-line direction:	North-South
Tie-line spacing:	Twenty miles
Flight path recorder:	Aeropath 35 mm continuous strip camera
Flight altitude:	1500 feet above mean sea level (barometric)
Navigation:	Visual, with reference to uncontrolled photo-mosaics at 1:63,360 and 1:253,440 scales.

GEOLOGY

The survey area is located in the central portion of the Great Artesian Basin. Thicknesses of 5000 to possibly 10,000 feet or more of Mesozoic sediments, including several thousand feet of marine Cretaceous shales, unconformably overlie a variably thick section of unmetamorphosed marine Upper Devonian, Ordovician, and Cambrian sediments. The basement in this region is composed of the Archaean and Proterozoic sedimentary, metamorphic, and igneous complexes, as opposed to that in the eastern portion of the Great Artesian Basin where metamorphism of the Palaeozoic rocks has resulted in a much thinner sedimentary section.

Of particular significance is the presence of several domal structures in the eastern part of the survey area near Innamincka and Cordillo Downs. These folds, many of which have surface closures of several hundred feet, are considered to be tectonic in origin and possibly controlled by "bedrock" faulting believed to trend beneath the basin in the same general direction as the strike of the folds.

RESULTS

General

The contours of the total magnetic field intensity and the geophysical interpretation of the survey data are illustrated by the maps (Plates 1 and 2) accompanying this Publication.

The magnetic pattern exhibited in the survey area is generally one of gentle, broad features in the centre, and somewhat more restricted and intense anomalies around the edges, particularly in the west. No overall orientation of the magnetic pattern is discernible, and the order of local magnetic relief ranges up to about 300 gammas. Individual anomalies are undoubtedly not completely resolved, because of the relatively great depth to the magnetic horizon causing them and to the relatively wide interval between flight lines.

The interpretation of the aeromagnetic data indicates the presence of a large, interrupted basin, the axis of which trends northwest-southeast, from the southern part of Sheet 1 to the north-central part of Sheet 6. The basin is interrupted by a broad saddle which trends north-eastward from the south-western part of Sheet 3 to the south-western corner of Sheet 2.

The contrasting magnetic contour patterns existing over the survey area suggest that the rocks giving rise to the magnetic anomalies may be broadly divided into four rock units on the basis of their relative magnetic susceptibilities, which are related to the chemical compositions of the rocks. The four rock units are designated A, B, C, and D on the accompanying maps (Plates 1 and 2).

Two profound major faults or fault systems have been interpreted, one striking east-west along the northern edge of Sheet 3 and another striking northeast-southwest in the southeast-centre of the survey area, through the north-western corner of Sheet 6 and the south-western and central portions of Sheet 4. These faults have apparently modified, or perhaps even controlled, the formation of the two sub-basins.

Estimates of the depth below sea level of the magnetic horizon giving rise to the anomalies have been made at a large number of localities, and contours based on these depth estimates have been drawn. Comparison of the depth estimates with seismic and drilling data suggests that the magnetic horizon correlates with the top of the "red bed" sediments in the Patchawarra and Innamincka areas, and with the crystalline basement in the Birdsville and Roseberth areas.

Sheet 1

Sheet 1, located in the north-western part of the survey area, is dominated by a very broad, compound, positive anomaly occupying most of the southern half of the sheet. This feature has a maximum amplitude of about 150 gammas. The remainder of the sheet is characterized by an irregular pattern of smaller anomalies having an ill-defined northwest-southeast orientation.

Depth estimates suggest that the magnetic horizon is between 6500 and 7500 feet below sea level in the northern and western parts of the sheet, deepening to over 18,000 feet at the deepest part of the north-western sub-basin, in the south-central part of the sheet.

Sheet 2

A relatively strong magnetic pattern in the west and north-west, which is a continuation of the anomalous pattern on adjacent Sheet 1, is shown on Sheet 2. Individual anomalies are 25 to 50 gammas in amplitude with no clearly defined overall orientation. In the central and eastern part of the sheet, the amplitudes range from 5 to 25 gammas in local magnetic relief. The boundary between these zones of magnetic pattern is fairly well defined.

A fault is interpreted as trending north-east through the western part of the sheet, parallel to the axial portion of the Mount Howie-Curalle structure. Depth estimates suggest that the shallowest part of the magnetic horizon in Sheet 2 lies in the north-western part of the sheet, where the depth of the magnetic horizon is computed to be less than 5000 feet. The depth to the magnetic horizon probably increases to more than 10,000 feet below sea level in the eastern and southern parts of the sheet.

Sheet 3

Sheet 3 is located in the west-central part of the survey area. A strong, continuous magnetic gradient band exists along the northern edge of the sheet and is interpreted as a profound east-west fault in the magnetic horizon by virtue of its linearity and persistence. A more complex pattern of higher frequency anomalies is present in the south-western and central part of the sheet. Local magnetic relief is of the order of 25 to 50 gammas.

The depth estimates indicate that the magnetic horizon lies approximately 8000 feet below sea level over the south-western and central parts of the sheet, and deepens

abruptly in the north to form the basin area in the southern part of Sheet 1. To the east and north-east, the depth of the magnetic horizon increases more gently to form an apparent structural saddle centred around the junction of Sheets 1, 2, 3, and 4.

Sheet 4

This sheet is located in the east-central part of the survey area. The main magnetic pattern is one of large anomalies of variable relief (50 to 100 gammas) and fairly generalized shapes. In the north and north-east, the magnetic relief diminishes forming more restricted, irregular features with amplitudes ranging between 5 and 50 gammas. The boundary between these two contrasting areas is fairly well defined.

In the centre of Sheet 4 there is an undulating magnetic gradient band which is interpreted as a profound fault, or more probably a fault system, striking northeast-southwest and continuing on to adjacent Sheet 6. Seismic results indicate the existence of a complicated fault system in the sedimentary section in this area, conforming roughly in strike with the magnetic feature. The magnetic gradient band may represent a single major fault at depth which translates upward into a complicated fault zone. Alternatively, the magnetic expression of the fault system may not have resolved its multiple nature.

Another gradient band, trending approximately east-west and attributed to faulting in the magnetic horizon, is located in the eastern part of the sheet, and immediately north of Durham Downs Homestead.

Depth estimates on Sheet 4 are erratic and a "four-contoured" version of the magnetic horizon surface would probably be unreliable in this area because of the compound nature of the fault system discussed above, and the possibility that the magnetic horizon may be associated with a thick sequence of "red bed" sediments of unknown age as suggested by seismic results at Patchawarra and Innamincka. For this reason the western part of the sheet has not been contoured below 14,000 feet. The general aspect of the magnetic horizon is one of an irregularly shaped basin in the western part of the sheet and an area of shallow basement in the south-eastern region.

Sheet 5

Sheet 5, in the south-western part of the survey area, is characterized by a pattern of elongate, fairly intense north-south and northeast-southwest anomalies located in the western and south-eastern parts of the sheet. In the centre is an area dominated by a broad negative anomaly, which is succeeded in the north-east by a very large positive with amplitude in excess of 200 gammas.

The magnetic horizon rises significantly in the southern and south-eastern parts of the sheet, with a minimum depth estimate of 4000 feet below sea level in the south-eastern corner of the sheet. Across the northern and central parts, the depth to the magnetic horizon is estimated to be approximately 10,000 feet below sea level.

Sheet 6

The magnetic contour pattern displayed on Sheet 6 is complex. The western half is characterized by a group of relatively intense anomalies similar in character to the adjacent and western parts of Sheet 5. There is no systematic orientation. The local magnetic relief ranges between about 50 and 150 gammas. On the eastern half of the sheet, the local anomalous relief is greatly diminished. Individual features are irregular in shape, and the magnetic relief ranges between about 20 and 50 gammas.

In the central and eastern parts of Sheet 6, at its northern boundary and continuing northward into Sheet 4, are two major anomalies which are attributed to a small body of rock of somewhat more basic composition than its surroundings. Some structural relief may be associated with these two anomalies, as in the case at the Innamincka dome.

In the south-eastern corner of the sheet there is a discontinuous line of low amplitude anomalies trending northeast-southwest. This trend may indicate the presence of possible basement relief or may be due to a rock unit of slight susceptibility contrast with its surroundings, or it may be caused by a combination of these two effects.

Depth estimates in Sheet 6 indicate the magnetic horizon to be very deep in the north-western corner of the sheet. The depth may even exceed 20,000 feet west of the profound fault which extends into the north-western part of Sheet 6 from Sheet 4. Towards the southern part of the sheet the magnetic horizon appears to rise fairly sharply to a minimum depth of 5500 feet below sea level in the southwest-central part of the sheet. To the east and south-east the magnetic horizon rises more gradually.

Reconnaissance Profiles

In addition to the interpretation of the regular network of traverses and tie lines flown in the main survey area, an interpretation was made of the results of two sets of single-line reconnaissance aeromagnetic profiles totalling approximately 10,800 linear miles, and of a southward extension, approximately 143 miles in length, of the westernmost tie line of the main survey.

(i) Bureau of Mineral Resources Profiles:

These fourteen profiles, totalling 8721 line-miles, were flown across the western part of the Great Artesian Basin. Portions of several profiles traverse the main survey area but the majority are located in the peripheral areas, extending as far north as Tennant Creek and Cloncurry, west to Alice Springs, and east to Charleville. These profiles were flown at an altitude of 1500 feet above ground level.

The interpretation of these profiles within the main survey area is in general agreement with the results of the subject survey. However, in the south-western part of Sheet 6 the more gentle dip of the magnetic horizon suggested by the profiles is a more plausible condition than that suggested by the interpretation of the main survey. Outside the main survey area, the profiles suggest that the magnetic horizon becomes shallower to the north and north-west but remains at the same order of depth to the east.

(ii) Santos Limited Profiles:

A rectangular grid of traverses totalling approximately 2000 line-miles and consisting of five east-west traverses spaced at intervals of approximately 35 miles crossed by six north-south tie lines had been flown earlier for Santos Limited. These traverses lie about 70 miles south of the main survey area in the Lake Torrens area of South Australia, and were flown at an altitude of 1500 feet above sea level.

The interpretation of these profiles suggests that the magnetic horizon becomes progressively shallower to the south.

(iii) Tie Line 1 Extension:

Tie Line 1 of the main survey was extended southwards along longitude 138°E from the southern boundary of the survey area to approximately latitude 38°18'S.

Interpretation of the profile suggests that the magnetic horizon rises from a depth of approximately 6000 feet below sea level at the survey area boundary to approximately 3000 feet below sea level at a point fifteen miles farther south. The magnetic horizon remains at this depth for a further 55 miles and then rises steadily over the next 35 miles where it reaches sea level, remaining at this depth for the remainder of the traverse.

(iv) Second Vertical Derivative Map:

The second vertical derivative map reveals thirty-nine features which are considered likely to be caused by relief on the basement surface or by a structural disturbance. However, because of the wide spacing of the traverses and the consequent large radius of the grid used for second derivative computation, it was not possible to derive depth estimates of higher precision than those obtained during the interpretation of the total intensity map.

ADDITIONAL DATA FILED IN THE BUREAU OF MINERAL RESOURCES

The following additional data relating to the Innamincka-Betoota Aeromagnetic Survey have been filed in the Bureau of Mineral Resources, Canberra, and are available for reference:

(i)	Final Report, by K.N. Isaacs and C.E. Curtis	68 pp.
(ii)	Interpreted profiles	18 sheets
(iii)	Generalized interpretation of geophysical surveys, South Australia and Queensland. Map scale 1:1,550,000 (approx.)	1 sheet
(iv)	Interpretation Report, Second Vertical Derivative, by M.S. Reford and K.N. Isaacs	30 pp.
(v)	Second Vertical Derivative Map, scale 1:240,000	2 sheets

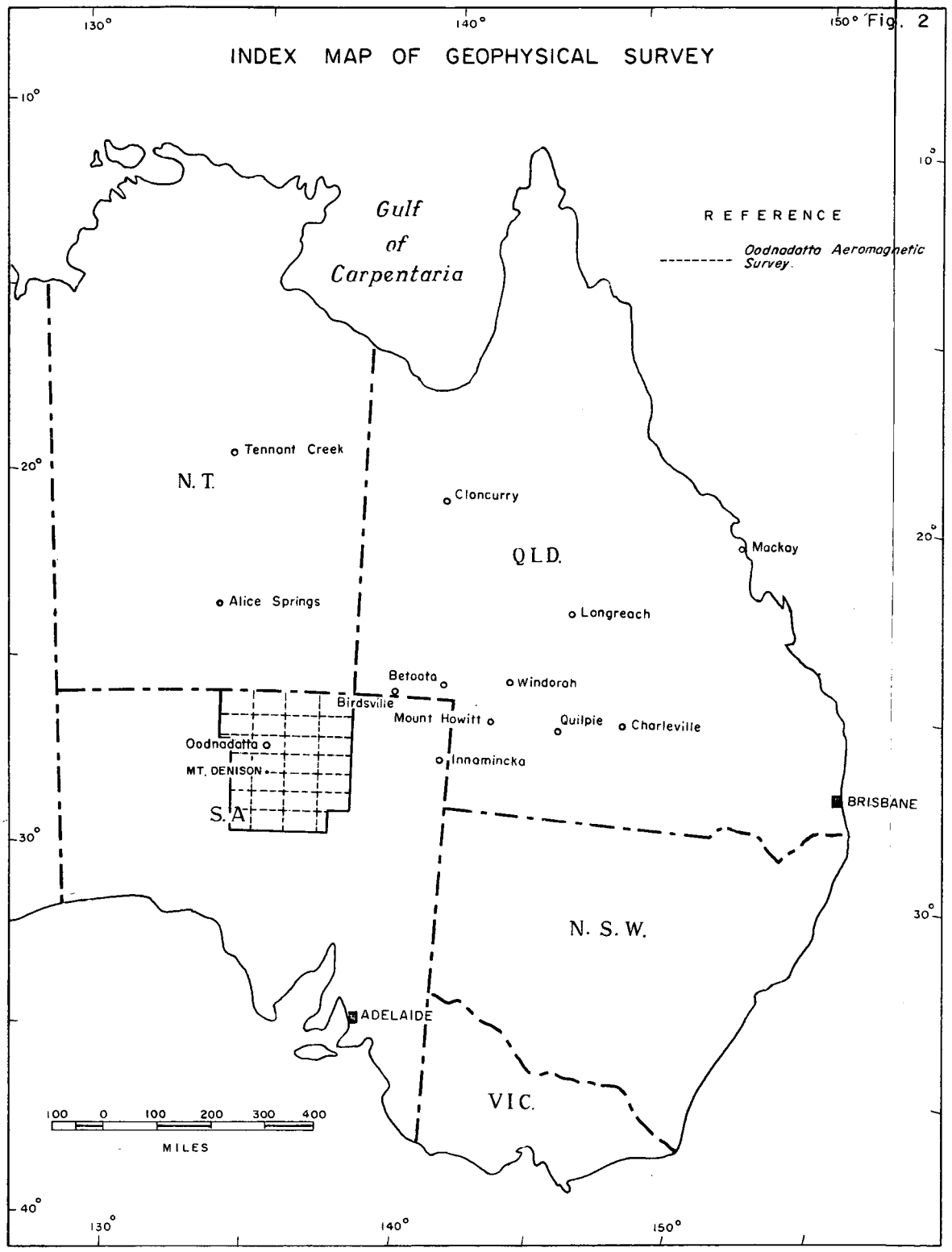
OODNADATTA AEROMAGNETIC SURVEY

by

DELHI AUSTRALIAN PETROLEUM LTD

SUMMARY OF DATA AND RESULTS

Fig. 2


INDEX MAP OF GEOPHYSICAL SURVEY
130°
140°
150°
10°
20°
30°
40°
Gulf of Carpentaria
REFERENCE
Oodnadatta Aeromagnetic Survey.
Tennant Creek
N. T.
Cloncurry
QLD.
Mackay
Alice Springs
Longreach
Betoota
Windorah
Birdsville
Mount Howitt
Quilpie
Charleville
Oodnadatta
Innamincka
MT. DENISON
S. A.
BRISBANE
N. S. W.
ADELAIDE
VIC.
100 0 100 200 300 400
MILES

OODNADATTA AEROMAGNETIC SURVEY

SUMMARY OF DATA AND RESULTS*

SUMMARY

A reconnaissance aeromagnetic survey in the Oodnadatta area of South Australia (see Fig. 2) was carried out between 18th November, 1961 and 9th January, 1962, for Delhi Australian Petroleum Ltd by Aero Service (Bahamas) Ltd. The project area lies within Oil Exploration Licences Nos 20 and 21, South Australia, and covers part of the Great Artesian Basin.

The purpose of the survey was to obtain reconnaissance aeromagnetic coverage in order to determine the depth, configuration, and general composition of the basement, and indications of structural features which could be further evaluated by other means as possible locations favourable to the accumulation of petroleum. Second vertical derivative maps were computed in order to supplement the information obtained from the total magnetic intensity contour maps.

Traverses oriented east-west at intervals of five miles, and tie lines oriented north-south at intervals of twenty miles were flown at a barometric altitude of 1500 feet above sea level. A total of 13,957 flight line-miles was surveyed. Oodnadatta was the base of operations.

A Gulf Research and Development Company Mark III total field magnetometer of the self-orienting saturable core fluxgate type mounted in a tail boom installation on a Piper Apache aircraft was used to record variations in the intensity of the earth's total magnetic field. Navigation was by visual means with reference to available uncontrolled photo-mosaics, and an Aeropath 35 mm continuous strip film camera was used to record the actual flight path. A Gulf Research and Development Company magnetic storm monitor was operated continuously at the survey base in order to avoid survey operations during periods of abnormal magnetic activity.

The survey data were compiled and interpreted by Aero Service Corporation, Philadelphia, Pa., U.S.A. The total magnetic intensity contour maps were prepared as a set of eight sheets at a scale of 1:120,000. This summary is accompanied by two composite reductions of the total magnetic intensity maps at a scale of 1:500,000 to which have been added the interpreted data.

The interpretation of the survey data postulates the existence of three broad, deep basins in the north-western, north-eastern, and east-central parts of the survey area. These basins are separated by broad basement arches and/or extensive areas where the basement rocks are either exposed or relatively close to the surface. Shallower basement depressions are located at the western edge of the survey area to the west of Oodnadatta, along a trough west of the Peake and Denison Ranges, and in the south-central part of the area. The basement underlying approximately one-third of the survey area is at a depth below sea level of less than 2000 feet. In the remaining two-thirds, the basement varies in depth from 2000 feet to more than 12,000 feet below sea level in the basins in the north-eastern and north-western parts of the area.

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* Abstracted from: Final Report - Interpretation of Airborne Magnetometer Survey in South Australia, for Delhi Australian Petroleum Ltd, by Stephen A. Terry, Aero Service Corporation, July, 1962.

Examination of the total magnetic intensity contour maps, with reference to the amplitude, area, shape, frequency, and orientation of the anomalies, suggests that the basement rocks in the survey area may be divided into three broad units of different composition, arbitrarily designated "A", "B", and "C". Unit A is characterized by a relatively low level magnetic intensity and low amplitude anomalies. Areas designated "A" on the attached maps (Plates 3 and 4) are therefore considered to be underlain by relatively acidic basement rocks. Unit B is characterized by anomalies of highly variable character which are generally of greater amplitude than those arising from Unit A, and areas designated "B" on the maps are therefore considered to be underlain by basement rocks of composition intermediate between basic and acidic. Areas designated "C" on the attached maps include the highest amplitude anomalies recorded during the survey and are considered to be underlain by basic rocks containing a relatively high percentage of ferromagnetic minerals. The interpreted basement rock boundaries shown on the maps are approximate in location and regional in nature.

The second vertical derivative map provided information that was of assistance in interpreting the probable source of individual magnetic anomalies, especially the weaker features. The majority of the anomalies are believed to be caused by variations in the composition of the basement rocks. However, on the basis of the additional information provided by the second vertical derivative map, twenty-two anomalies were selected as possible indications of local basement relief and/or structural disturbance. The pattern of the anomalies on the second vertical derivative map also provided confirmatory evidence of the existence of a possible fault or fault zone trending south-westerly through the south-eastern corner of Sheet 4 and extending into the northern portion of Sheet 6, and of the existence of two major trend directions (north-east and north-north-west) which may be related to the regional structural frabric of the basement. However, the wide spacing of the second derivative grid caused by the 5-mile traverse interval precluded the possibility of obtaining accurate depth estimates from the second derivative data.

In the extreme south-western part of the survey area (Sheet 7) there are two areas of intense anomalies whose characteristics of intensity and shape suggest that they are caused by relatively shallow concentrations of magnetic iron minerals of possible economic interest.

The geophysical operation undertaken in the Oodnadatta area of the Great Artesian Basin, South Australia, was subsidized under the Petroleum Search Subsidy Act 1959.

METHODS OF OPERATION

General Data

Operator:	Delhi Australian Petroleum Ltd, 32 Grenfell Street, Adelaide, South Australia
Contractor:	Aero Service (Bahamas) Ltd, Division of: Aero Service Corporation, Philadelphia, Pa., U.S.A.
Location:	Northern South Australia, extending south from the Northern Territory Border for a distance of approximately 255 miles. Project area bounded by latitudes 26°00'S and 29°40'S, and longitudes 134°00'E and 138°00'E.
Petroleum Tenements:	Oil Exploration Licences Nos 20 and 21, issued by the State of South Australia
Tenement Holders:	Delhi Australian Petroleum Ltd and Santos Limited
Basin:	Great Artesian

Field Operations

Date survey commenced:	18th November, 1961
Date survey completed:	9th January, 1962
Total survey mileage:	13,957 line-miles
Operational Base:	Oodnadatta
Aircraft:	Piper Apache
Magnetometer:	Gulf Research and Development Company Mark III total field magnetometer
Diurnal control:	Gulf Research and Development Company magnetic storm monitor, continuously recording total magnetic field intensity
Traverse direction:	East-West
Traverse spacing:	Five miles
Tie-line direction:	North-South
Tie-line spacing:	Twenty miles

Flight path recorder:	Aeropath 35 mm continuous strip camera
Flight altitude:	1500 feet above mean sea level (barometric)
Navigation:	Visual, with reference to uncontrolled photo-mosaics and available maps.

RESULTS

General

The compilation results of the survey are presented in the composite maps (Plates 3 and 4) accompanying this Publication. The survey has revealed considerable information about the underlying basement rocks. The interpretation has permitted the delineation of the general configuration of the basement surface, its depth range, and the distribution and extent of three major basement rock types based on their magnetic expression.

The majority of anomalies displayed on the isomagnetic maps are believed to be caused by variations in the composition of the basement rocks. However, twenty-two anomalies were selected as possible indications of local basement relief and/or structural disturbances.

Three broad, deep basins were located in the north-eastern, north-western and central-eastern parts of the survey area, and three less prominent basement depressions were also determined. Computed sedimentary thicknesses vary from less than 2000 feet, over about one-third of the survey area, to more than 12,000 feet in the deep basin areas.

The isomagnetic maps should be a useful guide for further exploration programmes in the area. Additional geological and geophysical information will be required to evaluate the accuracy of the interpretation.

Sheet 1

The north-western portion of the sheet contains a random distribution of total magnetic field anomalies of variable size, shape, intensity, and orientation. This area, designated "B", is probably underlain by a relatively shallow crystalline basement that is quite variable in composition. An area of similar magnetic character is located in the south-western portion of the sheet and it extends into Sheet 3.

The remainder of Sheet 1, designated "A", contains broad anomalies that are caused by contrasts in a generally acidic basement. The most prominent composition change is indicated by the large negative anomaly in the central portion of the sheet, flanked to the north-west by a strong positive anomaly. The total magnetic relief exhibited by these two features is 624 gammas. The computed susceptibility contrast is 0.0018 cgs. units, which suggests that the source is a mildly basic rock unit.

The contoured depth estimates reveal a broad centrally-located basin, the axis of which is oriented north-east, with a maximum depth to basement of more than 12,000 feet below sea level. The basement rises to less than 2000 feet below sea level in the north-western and south-western corners of Sheet 1. To the east and south-east, the basement rises more gradually onto a broad basement arch which occupies the eastern part of the sheet and whose minimum depth is approximately 8000 feet below sea level.

Seven anomalies, which appear as weak variations in the observed total magnetic field and which are considered to be areas of possible structural significance are outlined on the attached map (Plate 3). The low amplitude of these selected anomalies and the masking effect of the stronger anomalies arising from composition variations in the basement, is reflected in their imperfect resolution on the second vertical derivative map. However, this map reveals a predominant north-east directional alignment of the strong basement anomalies which may be related to the regional structural fabric of the basement rocks.

Sheet 2

The low magnetic relief observed over the area covered by this sheet suggests that the underlying basement rocks are acidic in composition. The contoured depth estimates show that the basement surface varies in depth below sea level from a maximum of more than 12,000 feet in the south-central and north-western parts of the sheet to a minimum of less than 10,000 feet in the central part where a broad basement "high" is indicated.

This sheet shows a series of low amplitude trends superimposed on very broad, low amplitude undulations in the magnetic field intensity. The strike of the superimposed trends varies from due north to 310°, averaging 330°. However the north-western quadrant of the sheet includes a group of linear magnetic features trending north-east, parallel to the strong regional trend noted on Sheet 1. The general conformity of the magnetic features with the two major trend directions is strongly illustrated by the second vertical derivative map.

Ten anomalies of possible structural significance are outlined on the accompanying map (Plate 3).

Sheet 3

The variable character of the anomalous magnetic pattern provides the basis for delineating the basement rock boundaries as shown on the interpretation map. Rocks of Unit B designation underly the north-western, south-western, south-eastern and east-central portions of the sheet. The amplitude of anomalies within these areas is as much as 750 gammas. These relatively strong features are caused by basement rock contrasts that are intermediate in composition between basic and acidic.

Most of the remaining area, which is designated "A", is characrerized by gentle magnetic relief due to acidic basement rocks. However, within this area there are a number of strong, isolated anomalies that reflect individual basement contrasts similar to those within the "B" areas. Anomalies of this type are located to the west and south-west of Oodnadatta and in the north-eastern quadrant of the sheet.

The basement depth contours indicate the existence of a basement "high" in the north-west of Sheet 3 as an extension of the shallow area in the south-west of Sheet 1. To the south of this basement "high" there is a local basin in which the basement depth exceeds 6000 feet below sea level, and the basement rises to less than 2000 feet below sea level in the south-western corner of Sheet 3.

Precambrian rocks crop out in the south-eastern corner of the area mapped on Sheet 3. These outcrops are related to the larger exposures of Precambrian igneous and metamorphic rocks of the Peake and Denison Ranges to the south-east. The depth contours indicate that a basement ridge extends north-westward from its outcrop area and continues to the north-west of Oodnadatta. The ridge is flanked to the north-east and south-west by parallel basement troughs.

The second vertical derivative map provides good resolution of the strong anomalies due to intrabasement susceptibility contrasts. The linear character of the magnetic trends, not readily discernible on the total magnetic intensity contour maps, is emphasized by the second vertical derivative process. The two major trend directions previously noted are repeated in Sheet 3. Two areas are delineated as possible local basement structures.

Sheet 4

In the west-central region of the isomagnetic sheet, the contour pattern reveals a roughly circular area of complex magnetic anomalies that vary in amplitude from a few tens of gammas to about 700 gammas. This "B" area is interpreted as the magnetic expression of a relatively shallow, heterogeneous basement rock mass. It is probably as variable in composition and structural complexity as the area of exposed basement in the Peake and Denison Ranges which it resembles in magnetic character.

Another area of rock unit B extends southward from the central part of the sheet into Sheet 6. This area consists of a group of broad, moderately intense magnetic anomalies that are caused by strong composition variations in the basement.

The unit boundaries in the south-western portion of the sheet are related to larger areas of similar character to the south. The remainder of Sheet 4 consists of a variety of anomalies and magnetic trends that are lower in magnetic relief, and are probably caused by variations in the composition of an essentially acidic basement.

The depth contours show a broad basin in the south-central part of the sheet where the depth to basement is greater than 10,000 feet below sea level. The basement surface rises to less than 2000 feet below sea level in the south-western and west-central portions of the sheet, and to less than 6000 feet below sea level in the south-eastern corner. A broad basement arch occupies the central area of the sheet and separates the basin to the south from a basin to the north.

Many of the parallel linear magnetic trends observed in the magnetic pattern of Sheet 2 extend into Sheet 4. In the south-eastern part of the sheet there is an abrupt termination and/or direction change of these trends, accompanied by a decrease in the general magnetic intensity level. These variations in the magnetic pattern are interpreted as the expression of a fault or fault zone as shown on the accompanying map (Plate 3). The second vertical derivative map strongly reflects the linear character of most of the total magnetic field features and emphasizes the variation in trend alignment believed due to faulting.

One feature is delineated as possibly being due to local basement structure.

Sheet 5

The magnetic variations over most of the area covered by this sheet are extremely complex in character. The anomalies within the area designated "B" vary greatly in shape, size, orientation, and magnetic intensity. Many of these features are of such limited extent that they are poorly resolved by the wide flight line spacing that was utilized during the survey. The underlying basement is probably composed of a complex distribution of igneous and metamorphic rocks of variable composition.

In the eastern part of the sheet, a broad zone characterized by a lower magnetic intensity level extends partially across the area in a south-eastward direction. This area, designated "A", is probably related to a generally acidic basement rock unit. It is terminated at its southern end by a group of strong anomalies within a zone that extends eastward into Sheet 6. These anomalies may be the magnetic expression of a large basic intrusive mass.

In the southern portion of the sheet, the magnetic level decreases rapidly along an east-west gradient which forms the southern limit of the "B" area. A zone of minimum magnetic intensity extends more or less continuously across the area near the sheet edge, and continues into the south-western part of Sheet 6. The underlying basement in this area is generally acidic in composition but it includes local contrasts that are magnetically expressed as sharp anomalies of limited areal extent.

Depth estimates indicate the existence of a basement trough with a maximum depth exceeding 4000 feet below sea level in the eastern part of the sheet. The basement complex underlying the remainder of the sheet is generally less than 2000 feet below sea level and locally rises to the surface.

The second vertical derivative map reflects the distribution of magnetic anomalies that are caused by basement rock susceptibility contrasts. A strong linear anomaly on the second vertical derivative map along the eastern edge of the basement trough may reflect a fault or fault zone.

Sheet 6

The isomagnetic map shows an eastward continuation of the high frequency complex magnetic pattern displayed on Sheet 5. Area B along the western part of Sheet 6 is the magnetic expression of exposed and shallow basement rocks of intermediate composition and heterogeneous character.

Area C, however, exhibits a striking contrast in magnetic intensity. Total magnetic relief between this area and the surrounding area approaches 3000 gammas. The average computed susceptibility contrast between this rock unit and the surrounding rocks is 0.0084 cgs. units, which indicates an average bulk magnetite content of about three percent. Thus, it can be inferred that the intense anomalies in this area are caused by basic rock masses that are distributed over a large area.

Areas of strong basement contrast in the north-central and south-eastern parts of the sheet are designated "B". The remainder of the area includes anomalies of less intensity that reflect minor variations in a generally acidic basement.

The contoured depth estimates show that the basement remains relatively shallow for a considerable distance east of its exposure in the Peake and Denison Ranges. The basement surface then increases in depth to more than 8000 feet below sea level in the north-central portion of the sheet; then rises to less than 6000 feet below sea level in the north-eastern corner and along the southern part of the sheet.

The second vertical derivative map shows strong anomalies in the western part of the sheet reflecting the sharp observed variations in total magnetic field intensity. In the central and eastern portions of the sheet the second vertical derivative anomalies are randomly oriented features that lack the distinct directional alignment so well developed on the sheets to the north. This suggests that the composition variations of the underlying basement rocks are gradational over broad areas.

Two areas of possible local basement structure are delineated on the accompanying map (Plate 4).

Sheet 7

The areas designated "C" on the interpretation map contain extremely high intensity magnetic anomalies, one of which exceeds 6000 gammas in amplitude. This feature and numerous others exhibit characteristics of intensity and shape that indicate they are caused by concentrations of magnetic iron minerals of economic interest at relatively shallow depth.

The western "C" zone exhibits easterly alignment of the magnetic anomalies and may extend westward beyond the limits of the present survey. The anomalies in the other "C" zone show strong north-westerly directional alignment which is probably the major strike direction of the zones of mineralization. These features probably extend to the south, beyond the survey boundary.

The "B" areas include anomalies of moderate intensity and variable shape that are due to contrasts in the basement that is intermediate between basic and acidic. The remainder of the sheet is characterized by a lower magnetic intensity level interpreted as the magnetic expression of generally acidic basement rocks.

Scattered depth estimates show that all but the eastern part of the sheet is underlain by basement rocks that are shallower than 2000 feet below sea level.

The second vertical derivative control covers only the eastern portion of the sheet and exhibits strong resolution of the magnetic features caused by basement rock susceptibility contrasts.

Sheet 8

Only the north-western part of this sheet was covered by the survey. The broad anomalies and trends recorded in this area are caused by strong contrasts in a generally acidic basement.

The depth estimates reveal a local basin area in which the depth to basement is greater than 4000 feet below sea level. The second vertical derivative map generally repeats the pattern of the total magnetic field intensity contour map.

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ADDITIONAL DATA FILED IN THE BUREAU OF MINERAL RESOURCES

The following additional data relating to the Oodnadatta Aeromagnetic Survey have been filed in the Bureau of Mineral Resources, Canberra, and are available for reference:

(i)	Final Report, by S.A. Terry	37 pp.
(ii)	Total magnetic intensity map, scale 1:240,000	2 sheets
(iii)	Total magnetic intensity map, scale 1:120,000	8 sheets
(iv)	Second vertical derivative map, scale 1:240,000	2 sheets

Plate 1

INNAMINCKA-BETOOTA AREA, SOUTH AUSTRALIA AND QUEENSLAND

TOTAL MAGNETIC INTENSITY AND GEOPHYSICAL INTERPRETATION

(DELHI AUSTRALIAN PETROLEUM LTD.)

SCALE 1 : 500,000

10 0 10 20 30

MILES

Reference

- Total magnetic field intensity contours
- •9,500 Depth estimate (feet below sea level)
- 2,000 Basement depth contour
- Anomaly source
- ? Probable fault
- Generalised basement rock unit boundary
- A,B & C Basement rock units

INDEX TO SHEETS

1	2
3	4
5	6

Contour interval, 10 Gammas

Flight altitude, 1,500 feet barometric

Flight interval, 5 miles

Base intensity, arbitrary

Surveyed and compiled 1961, by
Aero Service Corporation, Philadelphia, Pennsylvania, U.S.A.

Plate 2

INNAMINCKA-BETOOTA AREA, SOUTH AUSTRALIA AND QUEENSLAND

TOTAL MAGNETIC INTENSITY AND GEOPHYSICAL INTERPRETATION

(DELHI AUSTRALIAN PETROLEUM LTD.)

SCALE 1 : 500,000

10 0 10 20 30

MILES

SHEET 2

SHEET 4

SHEET 6

Reference

- Total magnetic field intensity contours
- 9,500 — Depth estimate (feet below sea level)
- 2,000 — Basement depth contour
- Anomaly source
- ? — Probable fault
- Generalised basement rock unit boundary
- A,B,C & D — Basement rock units
- ? — Possible local basement structure

INDEX TO SHEETS

1	2
3	4
5	6

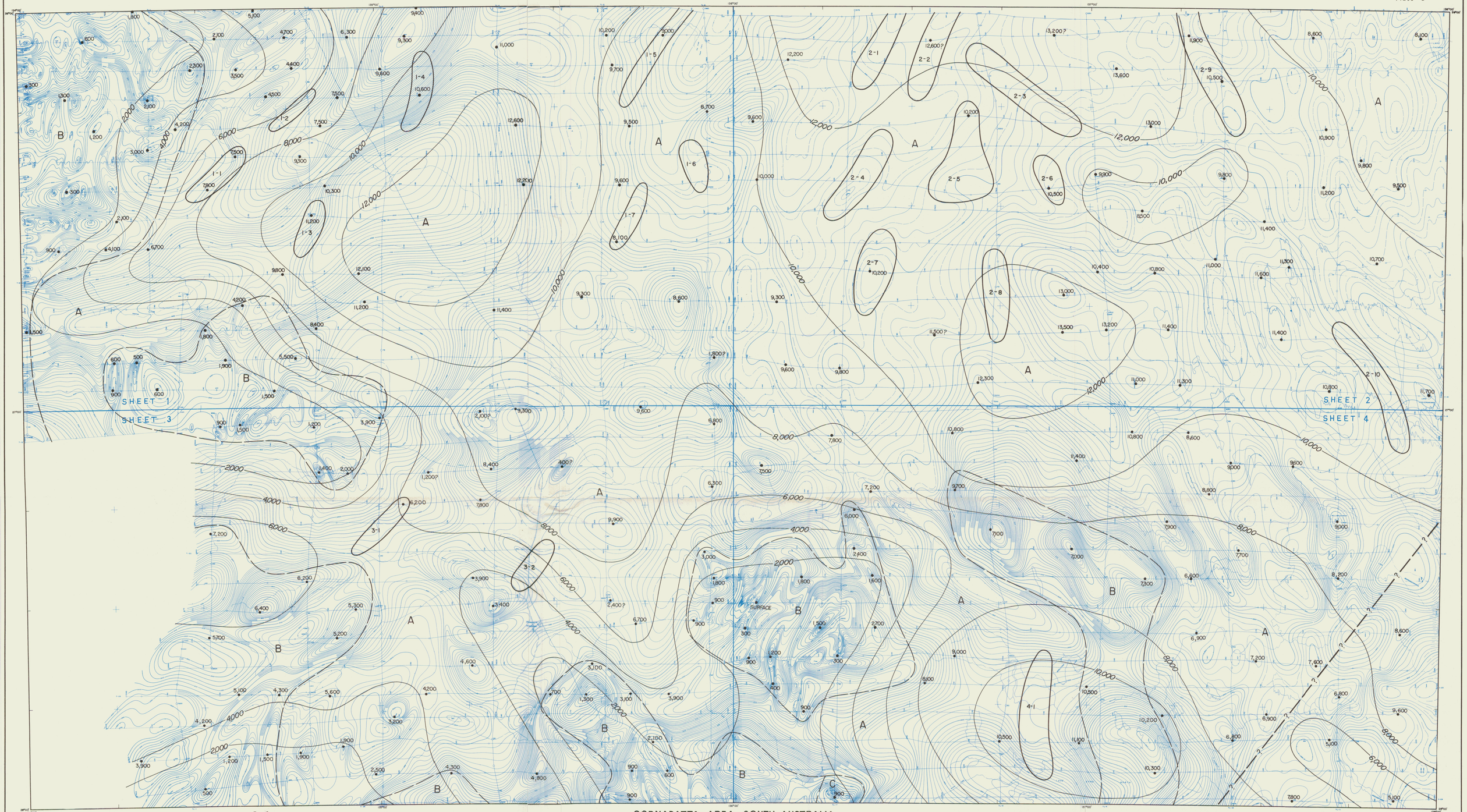
Contour interval, 10 Gammas

Flight altitude, 1,500 feet barometric

Flight interval, 5 miles

Base intensity, arbitrary

Surveyed and compiled 1961, by Aero Service Corporation, Philadelphia, Pennsylvania, U.S.A.



Reference

- Total magnetic field intensity contours
- •1,200 Depth estimate (feet below sea level)
- 2,000 Basement depth contour
- 3-2 Area of possible local basement structure
- ? Probable fault
- Generalised basement rock unit boundary
- A, B & C Basement rock units

OODNADATTA AREA, SOUTH AUSTRALIA

TOTAL MAGNETIC INTENSITY & GEOPHYSICAL INTERPRETATION

(DELHI AUSTRALIAN PETROLEUM LTD.)

SCALE 1:500,000

10 0 10 20 30
MILES

INDEX TO SHEETS

1	2
3	4
5	6
7	8

Contour interval, 10 Gammas

Flight altitude, 1,500 feet barometric

Flight interval, 5 miles

Base intensity, arbitrary

Surveyed and compiled 1961-1962, by
Aero Service Corporation, Philadelphia, Pennsylvania, U.S.A.

Plate 4

SHEET 5

SHEET 7

SHEET 6

SHEET 8

Reference

- Total magnetic field intensity contours
- 2,700 — Depth estimate (feet below sea level)
- 2,000 — Basement depth contour
- 3-2 — Area of possible local basement structure
- ? — Probable fault
- Generalised basement rock unit boundary
- A, B & C — Basement rock units

OODNADATTA AREA, SOUTH AUSTRALIA

TOTAL MAGNETIC INTENSITY & GEOPHYSICAL INTERPRETATION

(DELHI AUSTRALIAN PETROLEUM LTD.)

SCALE 1 : 500,000

10 0 10 20 30

MILES

INDEX TO SHEETS

1	2
3	4
5	6
7	8

Contour interval, 10 Gammas

Flight altitude, 1,500 feet barometric

Flight interval, 5 miles

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