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Mr Adams 9/1/64
Mr Viirk 9/1/64.
Mr Barclay 10/1/64
(Please incorporate in
Geological Library)

9/1/64

An

Airborne Magnetometer Survey

of

ALROY - WALLHALLOW, N.T.

(Oil Lease O.P. 73 (i) & (ii))

carried out by

ADASTRA HUNTING GEOPHYSICS PTY. LTD.

39-45 Vickers Avenue,

Mascot, N.S.W.

for

BARKLEY OIL COMPANY PTY. LTD.

137 Queen Street,

Brisbane, Q'land.

Field work carried out between

7th - 16th June, 1963

and

10th - 19th July, 1963

PART I

OPERATIONAL REPORT

PART II

INTERPRETATION REPORT

PART I

OPERATIONAL REPORT

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I INTRODUCTION

I. 1 GENERAL INFORMATION

Two areas were involved in this survey, a northern area known as WALLHALLOW covering Permit to Explore 73 (i) and a southern area known as ALROY covering Permit to Explore 73 (ii).

The survey was planned as an open reconnaissance with flight lines over both areas flown in a north-south direction at 5 mile intervals with a set of two lines spaced 2 miles apart every ten miles, i.e., in sequence 2 mile - 5 mile - 5 mile - 2 mile etc. Tie lines were flown at regular intervals of 10 miles in an east-west direction.

Approximately 3,590 square miles of territory were covered in the northern (WALLHALLOW) area, its centre lying roughly 170 miles north-east of the township of TENNANT CREEK in the BARKLY BASIN, Northern Territory.

The southern (ALROY) area covered approximately 3,740 square miles of territory, the centre of which lies roughly 70 miles due east of the township of TENNANT CREEK at the northern edge of the GEORGINA BASIN, Northern Territory.

Both areas, with the exception of the north-eastern section of Wallhallow, are fairly flat and featureless with average heights above sea level of 800 feet.

All flying operations were conducted from BRUNETTE DOWNS, N.T., latitude 18°38'S, longitude 135°56'E, using a Lockheed Hudson Mark III aircraft.

The whole survey was completed in approximately three weeks.

I. 2 PURPOSE OF THE SURVEY.

The aeromagnetic survey was carried out in order to gain information on the depth to basement, configuration and grain of basement, trends of major structural features including faults, magnetic intrusives and Basin edges (where applicable).

Information obtained from the survey to be used to define zones of interest in the search for oil bearing structures to which further exploration techniques could be applied with a reasonable amount of success.

II THE FLYING PROGRAMME

II. 1 PRE-FLIGHT PREPARATIONS

The locations of the lines and tie lines to be flown were firstly plotted on the 4 mile Topographic Series (Provisional Edition) maps of Wallhallow and Alroy published in November, 1960 and August, 1959 respectively.

These lines were then transferred to photomosaics prepared by Adastra Airways Pty. Ltd. from photography flown by the Royal Australian Air Force during October to November, 1947, at a height of 25,000 feet. The scale of the mosaics so prepared was reduced photographically to approximately 2 miles to 1 inch using the above mentioned survey maps as a base for control.

II. 2 PROGRAMME DETAILS

(i) Height

The survey was flown at a constant barometric altitude of 2,000 feet above mean sea level, resulting in an average terrain clearance of 1,200 feet, except for the north-eastern area of the Wallhallow area, where terrain clearance is unknown owing to lack of topographical information.

(ii) Flight Lines (Northern Area

Eighteen (18) north-south flight lines at intervals of two (2) and five (5) miles were flown, together with seven (7) east-west tie lines spaced at 7, 10, 10, 10, 10 and 16 mile intervals respectively reading from north to south. One tie line was flown in a northwest-southeast direction to tie the northeastern side of the area.

Flight Lines (Southern Area)

Fifteen (15) North-south flight lines at intervals of two (2) and five (5) miles were flown, together with seven (7) east-west tie lines spaced at eleven (11) mile intervals.

In Summary

Northern Area

18 north-south lines totalling	964	line	miles
7 east-west " "	386	"	"
1 north-west/south-east	48	"	"
	1,398	"	"

Southern Area

15 north-south lines totalling	1,032	line	miles
7 east-west " "	378	"	"
	1,410	"	"

Total of both areas 2,808 line miles.

Plate 7 shows the flight/tie line pattern achieved in relation to the area boundaries for the northern area.

Plate 8 shows the flight/tie line pattern achieved in relation to the area boundaries for the southern area.

III METHODS AND INSTRUMENTS USED FOR THE SURVEY

III. 1 AIRBORNE (TOTAL FORCE) MAGNETOMETER

The instrument used on this survey was a Gulf Mark III Total Force Magnetometer manufactured by the Gulf Research and Development Company, Pittsburgh, Pennsylvania.

The Airborne Magnetometer is intended primarily for measurements of the earth's total magnetic field intensity, and in particular, local variations in intensity such as may be caused by geological inhomogenieties.

The equipment comprises, a measuring or detecting element, an oscillator to excite it, a vacuum tube circuit to amplify and detect the output variations of the element, orienting devices (which keep the detector element aligned), a potentiometer circuit to compensate, or "buck-out" large changes of field, and a recorder for the magnetic variations encountered over the area surveyed.

The Airborne Magnetometer was designed for use in a moving aircraft, and yet it must provide a continuous and accurate record of the earth's total magnetic intensity. Because the aircraft does not accurately maintain its orientation in space, provision must be made to hold the measuring or detector element in a fixed orientation (parallel) with respect to the Earth's Total Field.

The Gulf Magnetometer uses the Earth's magnetic field itself as a reference, and the detector element is aligned with its axis of sensitivity parallel to this field. This arrangement places the detector element in the most favourable position, and errors due to improper orientation are at a minimum. Two other sets of detector elements are used to sense and seek the position of zero (null) field.

When the axis of sensitivity of the detector element is aligned parallel to the Earth's field, any error of alignment causes a decrease in reading by an amount proportional to the cosine of the error angle. Errors are therefore small for small angles of misorientation, being in fact of the order of 0.5 gamma for ½ degree, and 8.4 gamma for 1 degree misalignment in a total field of 55,000 gamma.

(a) RECORD

The speed of the aeromagnetic profile recorder was 3" per minute, and the full scale deflection (F.S.D.) was set at 600 gamma.

The value of the step (automatic reset procedure when variations of magnetic field exceed the f.s.d. (i.e., 600 gamma) was 500 gamma.

(b) CALIBRATION

The instrument was calibrated using a standard Helmholtz Coil registering 10 gamma per 1 milliampere of current.

(c) TESTS

(i) Lag Test.

Lag, or delay of the response considered in relation to the ground position of the aircraft, is due to a combination of the following:-

(i) Delay owing to electrical resistance in the circuitry

(ii) Delay owing to mechanical transference of received signal on to the paper record.

(iii) Delay owing to difference in position of recording camera with respect to detector head.

To find the total recorded lag it is necessary that the aircraft fly over an easily identifiable magnetic body on reciprocal courses, e.g., a ship - a large metal pipeline - an iron bridge etc., which will give a well defined sharp magnetic anomaly. Then by identifying the position of the centre of the body on the 35 m/m tracking film and plotting this point on the magnetometer chart, the difference between this point (average of two directions) and the peak of the magnetic anomaly from the body is the total lag for the installation.

The lag test for this survey was flown over the Sydney Harbour Bridge before the aircraft departed for the area.

The installation used on this survey was checked, as above, and no readable lag was detected - the fiducial index pen was aligned with the main recording pen.

(ii) Heading Effect.

The detector head (measuring fluxgate), aligning fluxgates and servo motors were towed behind the aircraft in a 'bomb' shaped bird. With this arrangement there is normally no heading effect, however a heading test was carried out in the area as a check. No heading effect was observed.

III. 2 35 m/m POSITIONING CAMERA

The instrument used for this survey to record the position of the aircraft in relation to the ground was a single frame 35 m/m camera using 400 ft. film capacity magazines, details of which are as follows:-

Type:	Vinten 35 m/m Geological Survey Camera
Focal Length:	28 m/m (1.10")
Shutter Speed:	1/250 sec. (constant)

Diaphragm Range: f2 - f32

Format: 18 m/m x 25 m/m

Intervals: ¾ sec. to 6 secs.

The camera was mounted in the aircraft with its optical axis set vertical for straight and level flight.

Exposures were made automatically using an electronically controlled intervalometer set at 1.5 and 2.0 second intervals. With the exposure interval so set, each 35 m/m frame is overlapped by approximately 25% - 30%, thus ensuring complete ground coverage.

The camera exposures were related to the magnetic field record by the use of a fiducial pen on the recorder which operated simultaneously with the camera Veeder counter at every hundredth exposure.

Du Pont type 936 thirty-five millimeter film rated at 160 A.S.A. was used throughout the survey.

Processing of this film was carried out by the Automatic Film Laboratories, Moore Park, Sydney.

(a) TESTS.

The correct functioning of the camera was tested daily prior to, and at the end of each sortie.

III. 3 RADIO ALTIMETER.

Apart from the barometric altimeter, which is standard equipment in all aircraft, a radio altimeter type APN-1 was used to record terrain clearance. The instrument was set on "high range" (0.4,000 ft.) throughout the survey.

An Esterline Angus recording potentiometer was used in conjunction with this instrument to obtain a continuous profile on five inch wide curvilinear chart recording at a speed of 3 inches per minute.

In order to check that the instrument was functioning correctly, the aircraft was flown over the base aerodrome before and after each sortie.

III. 4 STORM MONITOR.

With aeromagnetic surveys it is essential that any variation of the magnetic field is monitored and recorded throughout the duration of the survey on a 24 hour basis.

The normal diurnal change of field, which occurs daily, is of low gradient and cyclic, and can be compensated for in the standard flight line/tie line control pattern. However, any abnormal variation, when total magnetic field strength varies erratically over short periods, will affect the recorded results of all surveys carried out during these periods. Where such variations occur, reflying would be necessary.

The instrument used for this survey was a single fluxgate magnetometer manufactured by the Gulf Research and Development Company, Pittsburgh, Pennsylvania.

The complete equipment consisted of:-

(i) Fluxgate Element

(ii) Detector Head

(iii) "Buck out" magnet.

(iv) Tripod.

(v) Esterline Angus Recorder.

(vi) Compensator.

The fluxgate element employs the same principles as the airborne instrument, i.e., it comprises two coils having ferromagnetic cores which are driven cyclically through saturation. A secondary, or compensating coil surrounds both primaries, which are connected in series opposition, so arranged that one core saturates slightly ahead of the other. The resultant output is in the form of sharp pulses, and when there is no external magnetic field the positive and negative pulses are equal in amplitude.

Should an external field now be applied to these cores their times of saturation will be altered, which will cause a change in output.

To balance or null this introduced external field a current is passed through the secondary coil (surrounding the primaries), equal and opposite to the disturbing field.

It is this current which is measured, amplified, and passed through a recording potentiometer (Esterline Angus Recorder). This record is easily translated into magnetic units.

To ensure maximum sensitivity, a permanent magnet, supported by a ceramic structure, is mounted on the head together with the detecting element, and adjusted to "buckout" the major portion of the Earth's normal field at the location used.

The detecting element is aligned parallel to the direction of total field manually by using the position of maximum response.

(a) RECORD

The recorder chart speed was set at 1½ inches per minute whilst the aircraft was on survey, and 1½ inches per hour at all other times.

(b) CALIBRATION.

Prior to the commencement of the survey the instrument was calibrated using a standard Helmholtz coil.

Full scale deflection over the $4\frac{1}{2}$ inch wide recorder chart registered 240 gammas. The chart is divided into 50 divisions, thus each division has a value of 4.8 gamma.

The storm monitor was installed at the base aerodrome at Brunette Downs, N.T.

IV FLYING OPERATIONS

IV. 1 AIRCRAFT

A Lockheed Hudson aircraft registered letters VH-AGE was used to carry out this survey.

The Gulf III Magnetometer measuring head, aligning coils and servo-motors were towed in a 'bomb' shaped bird below the aircraft.

An average ground speed of 160 miles per hour was maintained by the aircraft throughout the survey period.

IV. 2 BASES.

The aircraft was based at Brunette Downs aerodrome for the entire survey.

IV. 3 MAPS AND MOSAICS.

The following maps, mosaics and aerial photographs were available at the time of the survey:-

World Aeronautical Charts (I.C.A.O.)

Scale: 1:1,000,000 (15.8 miles to 1 inch)

NEWCASTLE WATERS.

Commonwealth Topographic Survey Maps

Scale: 1:253,440 (4 miles to 1 inch)

ALROY

WALLHALLOW

Vertical Aerial Photographs

Scale: Approx. 1:50,000 (0.79 miles to 1 inch)

R.A.A.F. 9"x9" flown between

October - November, 1947.

Photomosaics - Semi Controlled

Scale: Approx. 2 miles to 1 inch

Prepared by Adastra Airways from the

above photography in two sheets.

IV. 4 RECORD OF OPERATIONS

Lockheed Hudson aircraft, VH-AGE, piloted by Captain W. Bowles, started operations from Brunette Downs on the 7th June, 1963.

Other members of the crew included M. Wood (Navigator), R. Nelson (Operator/Technician) and G. Clayton (Licensed Engineer).

On and after the 30th June, 1963 M. Wood was replaced by J. Tierney.

Survey operations were started on the northern (Wallhallow) area on the 7th June and were continuous until the 16th June, 1963.

On this date the northern area was completed, however the survey could not be continued owing to lack of mosaics for the southern (Alroy) area.

Operations were recommenced on the 10th July and were continuous until the 19th July, 1963, the completion date of the survey.

Abortive surveys were caused by the following:-

9th June, APN-1 Radio Altimeter malfunction.

10th June, Aircraft engaged on photographic work.

11th June, Crew stand-down period in accordance with A.N.O. Regulation 48.1.1.12 (Pilots)

12th June, APN-1 Radio Altimeter malfunction.

15th July, Crew stand-down period in accordance with A.N.O. Regulation 48.1.1.12 (Pilots)

V AIRBORNE PROCEDURE

V. 1 WARMING UP OF INSTRUMENTS

All electronic instruments were switched on and kept running for at least half an hour before recording began to ensure their proper and steady function.

V. 2 ANNOTATION OF RECORDS

During the survey records were annotated for future and plotting purposes, the following annotations being made:-

V. 3 AEROMAGNETIC RECORD

(i) Line identification and direction.

(ii) First fiducial number and every 100th. frame.

(iii) Time (synchronised with storm monitor)

(iv) Step numbers

(v) Recorder standardise, Marked R.S.

(vi) Measuring circuit standardise, marked STD.

(vii) Instrument drift errors.

V. 4 RADIO ALTIMETER RECORD

(i) Start and finish of lines showing line numbers and directions.

(ii) Camera fiducial numbers.

V. 5 DAILY FLIGHT REPORT.

These reports give a detailed description of the sorties from an operational point of view and show the following information:-

(i) Times of start and end of sortie.

(ii) Instruments used and relevant details.

(iii) 35 m/m photography numbers.

(iv) Times of start and finish of individual lines.

(v) Direction of lines flown.

(vi) Changes of film magazines and recording charts.

(vii) Navigator's diagram showing the flying achieved for the sortie and line direction.

VI GEOPHYSICAL TECHNIQUES

VI. 1 CONTROL OF OBSERVATIONS

Control of observations (magnetic datum) was achieved by the use of all tie lines flown and selected flight lines, so distributed to form rectangular circuits with approximately 10 mile sides.

At all these intersections readings were taken, and using a system of least squares, each control circuit was adjusted to a standard datum.

Lines used for control, distribution of errors and remaining errors are shown in Plate 2 of this report.

Oil lease area O.P.67, which was flown as a combined programme with this survey, occurs between the two areas Alroy and Wallhallow, therefore magnetic control datum and adjustments were made as a unit.

VI. 2 INSTRUMENT DRIFT

The instrument drift was checked at the end of each surveyed line using the normal standardising procedure. Both recorder and measuring circuit drifts were adjusted in this way.

VI. 3 REGIONAL CORRECTION

A regional correction has been applied to the Total Magnetic Intensity Contour Sheets as follows:-

Minus 10.25 gammas per line mile South

Minus 1.15 gammas per line mile West.

These values were taken from the Bureau of Mineral Resources Report No. 62 "Isomagnetic Maps of Australia for the Epoch 1957.5" corrected for Secular Change.

VI. 4 MAGNETIC INFORMATION

(Northern Area)

Total Force Field (F)	49,500 gammas
Inclination of Field (I)	- 46½ degrees
Deviation of Field (D)	5 degrees east.

(Southern Area)

Total Force Field (F)	50,800 gammas
Inclination of Field (I)	- 49½ degrees
Deviation of Field (D)	5 degrees east

VII REDUCTION OF DATA.

VII. 1 PLOTTING OF FLIGHT PATH AND TRANSFER TO OVERLAYS

The position of the aircraft over the ground recorded on the 35 m/m film was initially identified and plotted by reference to topographical detail depicted on the 2 mile to 1 inch semi-controlled photomosaics.

Density of plotting was on the average between 2 to 3 miles.

These stations were then transferred directly on to detail overlays at the same scale and used as a base for plotting intercepted values from the aeromagnetic profiles.

VII. 2 RELATING PROFILES TO THE PLOTTED FLIGHT PATH.

All points identified from the 35 m/m film and plotted on the final base sheets, were plotted on the aeromagnetic profile charts by interpolation. The points on the charts thus plotted were used to transfer intercepted profile readings.

VII. 3 DATUM LINING AND INTERCEPTING.

(i) Aeromagnetic profiles were referred to a common datum based on the adjusted values at the control intersections.

The datum value was selected sufficiently high to avoid any negative anomalies.

(ii) Intercepts from the aeromagnetic profiles were taken at minima maxima, and at intervals of 5 gammas. Where the anomaly gradients were steep, other intervals were selected according to the gradients.

(iii) The intercepted values were transferred to the base overlay maps using the 35 m/m stations to correct for various changes in direction and ground speed of the aircraft.

VIII MAPS, CHARTS, RECORDS, ETC. SUPPLIED ON COMPLETION OF THE SURVEY.

The following maps, charts, records etc., were supplied on completion of the survey:-

(i) All original Magnetometer Profile Charts with 35 m/m identified stations plotted and annotated, also positions of flight-line/tie-line intersections marked with adjusted datum values.

(ii) Xerox copies of all the above Magnetometer Profile Charts for supply to the Bureau of Mineral Resources.

(iii) All original Radio Altimeter Profile Charts showing height of aircraft above terrain with annotations similar to the Magnetometer Profiles.

(iv) All original Storm Monitor Profile Charts marked (whilst on survey), at ten minute intervals. These records show the variation of the magnetic field strength throughout the period of the survey.

(v) All original Daily Flight Reports listing traverses flown, 35 m/m film exposure numbers, directions of lines, times of start and finish of survey lines, and all pertinent operational data for each sortie flown.

(vi) 35 m/m tracking film for all successful traverses flown.

(vii) One bromide copy of each photomosaic showing the 35 m/m track plot at a scale of two miles to one inch.

(viii) Two 'Cronaflex' copies each of the Total Magnetic

Intensity Contour Sheets (2) at a scale of two miles to one inch showing skeleton planimetric detail.

(ix) Six dyeline copies each of the above sheets (2).

(x) One 'Cronaflex' copy of each Total Magnetic Intensity Contour Sheet reduced to a scale of four miles to one inch.

(xi) Twelve dyeline copies each of the above four mile sheets (to be included with Final Report).

(xii) Twelve copies of the final report, which will include one original 'Cronaflex' interpretation map at a scale of four miles to one inch for each sheet together with 12 dyeline copies of each.

IX PLATES

PLATE 1 - Locality Map.

PLATE 2 - Least squares adjustment of closure errors, and distribution of errors.

PLATE 3 - Specimen aeromagnetic profile with annotations.

PLATE 4 - Specimen radio altimeter profile with annotations.

PLATE 5 - Specimen storm monitor profile.

PLATE 6 - Specimen 35 m/m strip film.

PLATE 7 - Diagram showing positions of flight lines in relation to area boundaries, for northern (Wallhallow) area.

PLATE 8 - Diagram showing positions of flight lines in relation to area boundaries for southern (Alroy) area.

X APPENDIX

Index to lines and tie lines flown, direction, date flown and 35 m/m station numbers.

Height flown 2,000 ft. a.m.s.l.

Northern Area

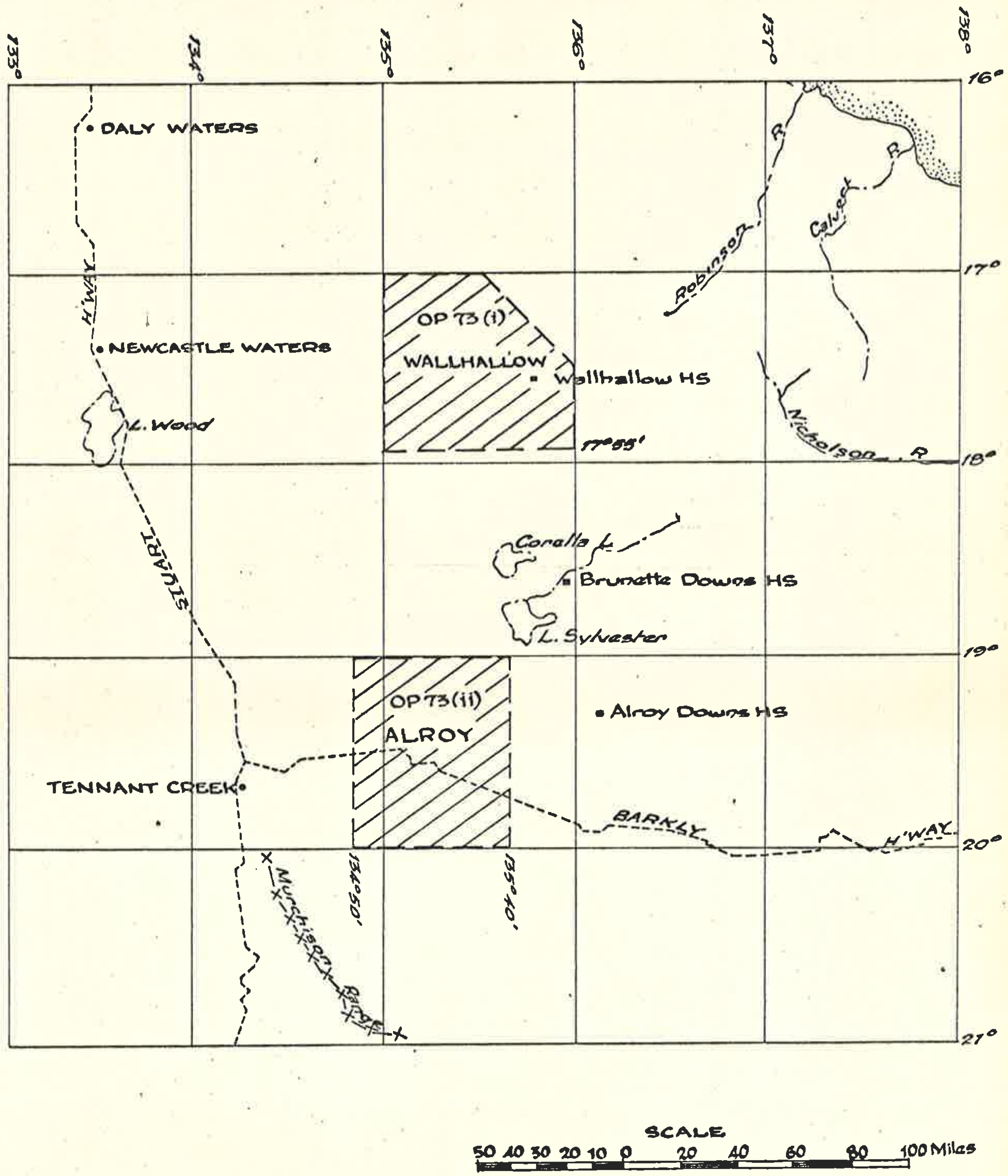
Line No.	Dir.	Date Flown	Station Nos.	Remarks
68	N	8.6.63	440 - 1370	
69	S	"	1380 - 2500	
70	N	"	2501 - 3450	
71	S	"	3470 - 4400	
71	N	15.6.63	2461 - 2780	Refly F - G
72	S	14.6.63	4211 - 5370	
73	S	15.6.63	1421 - 2460	
74	N	"	371 - 1420	
75	S	7.6.63	770 - 1729	
75	S	15.6.63	2781 - 3090	Refly F - G
76	N	"	3601 - 4430	T/L's A - F
76	N	"	3091 - 3450	T/L's F - G
77	N	14.6.63	101 - 1130	
78	S	15.6.63	4431 - 5330	
79	N	16.6.63	2081 - 2790	
80	N	7.6.63	180 - 769	T/L's E - G
80	S	16.6.63	2821 - 3150	T/L's E - Y
81	S	"	1511 - 2080	
82	N	"	1001 - 1510	
83	S	"	541 - 1000	
84	S	13.6.63	4371 - 4900	T/L's E - G
84	S	16.6.63	431 - 540	T/L's E - Y
85	N	"	71 - 430	
A	W	14.6.63	1131 - 1660	
B	E	"	1661 - 2470	
C	W	"	3431 - 4210	
D	E	13.6.63	3231 - 4370	
E	W	"	2281 - 3230	
F	E	"	1051 - 2280	

Northern Area (Cont'd.)

Line No.	Dir.	Date Flown	Station Nos.	Remarks
G	W	13.6.63	111 - 1000	
Y	S.E	14.6.63	2471 - 3430	

Southern Area

Line No.	Dir.	Date Flown	Station Nos.	Remarks
86	S	16.7.63	2981 - 3820	
87	N	"	3821 - 4570	
88	S	"	4571 - 5449	
89	N	17.7.63	1511 - 2330	
90	S	"	2391 - 3260	
91	N	19.7.63	4231 - 5040	
92	S	17.7.63	4011 - 4870	
93	S	19.7.63	3441 - 4230	
94	N	"	2612 - 3440	
95	S	"	1811 - 2620	
96	N	"	941 - 1810	
97	S	"	81 - 940	
98	S	17.7.63	101 - 1010	
99	S	16.7.63	101 - 940	
100	S	14.7.63	1801 - 2710	
Q	W	10.7.63	2031 - 2640	
R	W	13.7.63	2531 - 3100	
S	E	"	3101 - 3860	
T	W	16.7.63	2301 - 2980	
U	E	"	1661 - 2300	
V	W	"	941 - 1660	
W	W	14.7.63	2711 - 3270	

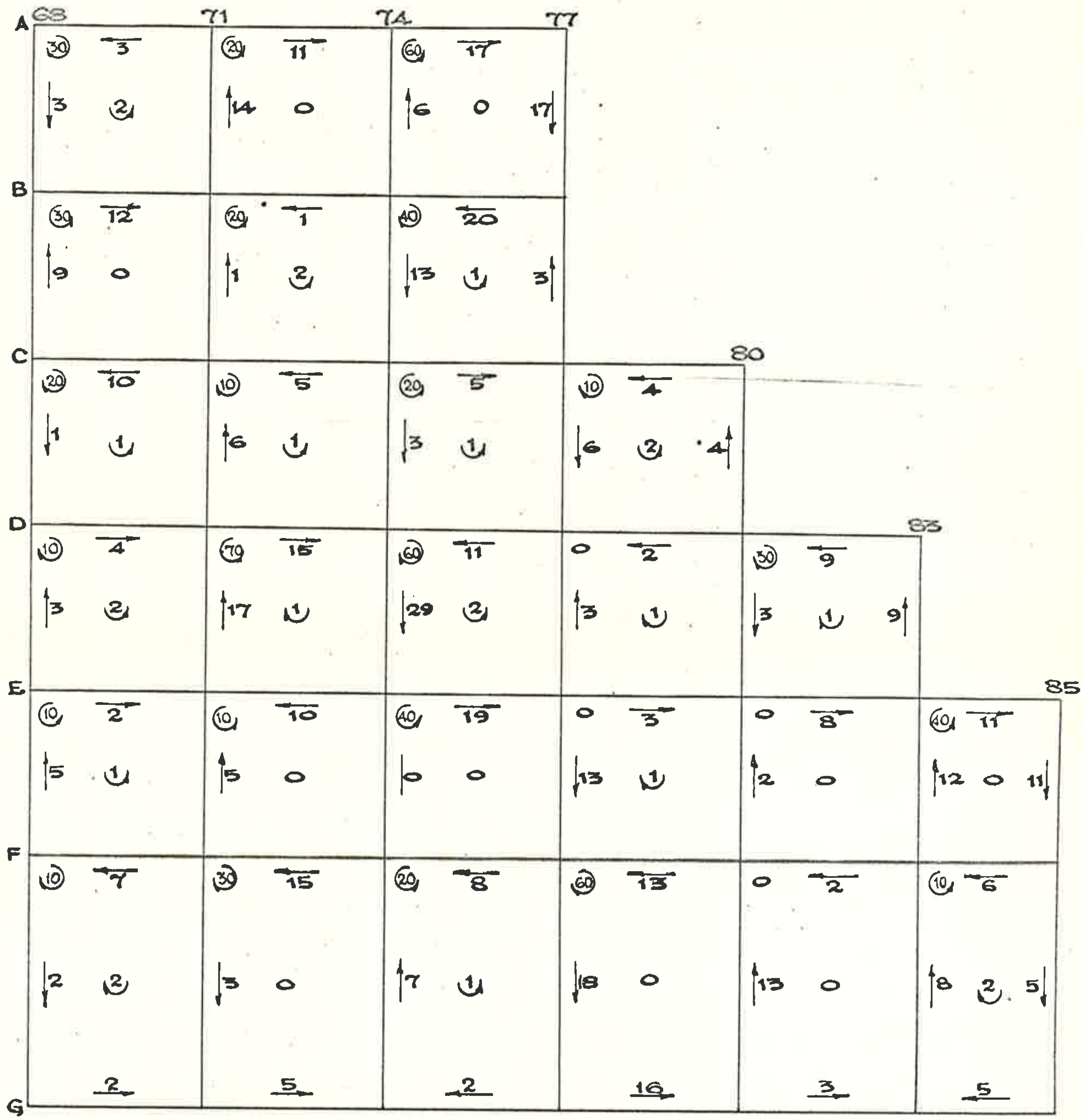


~LOCALITY MAP~

AHGL Mascot

PLATE 1.

LEAST SQUARES CORRECTIONS



(30) Original Closing Area in Gammas x 10.

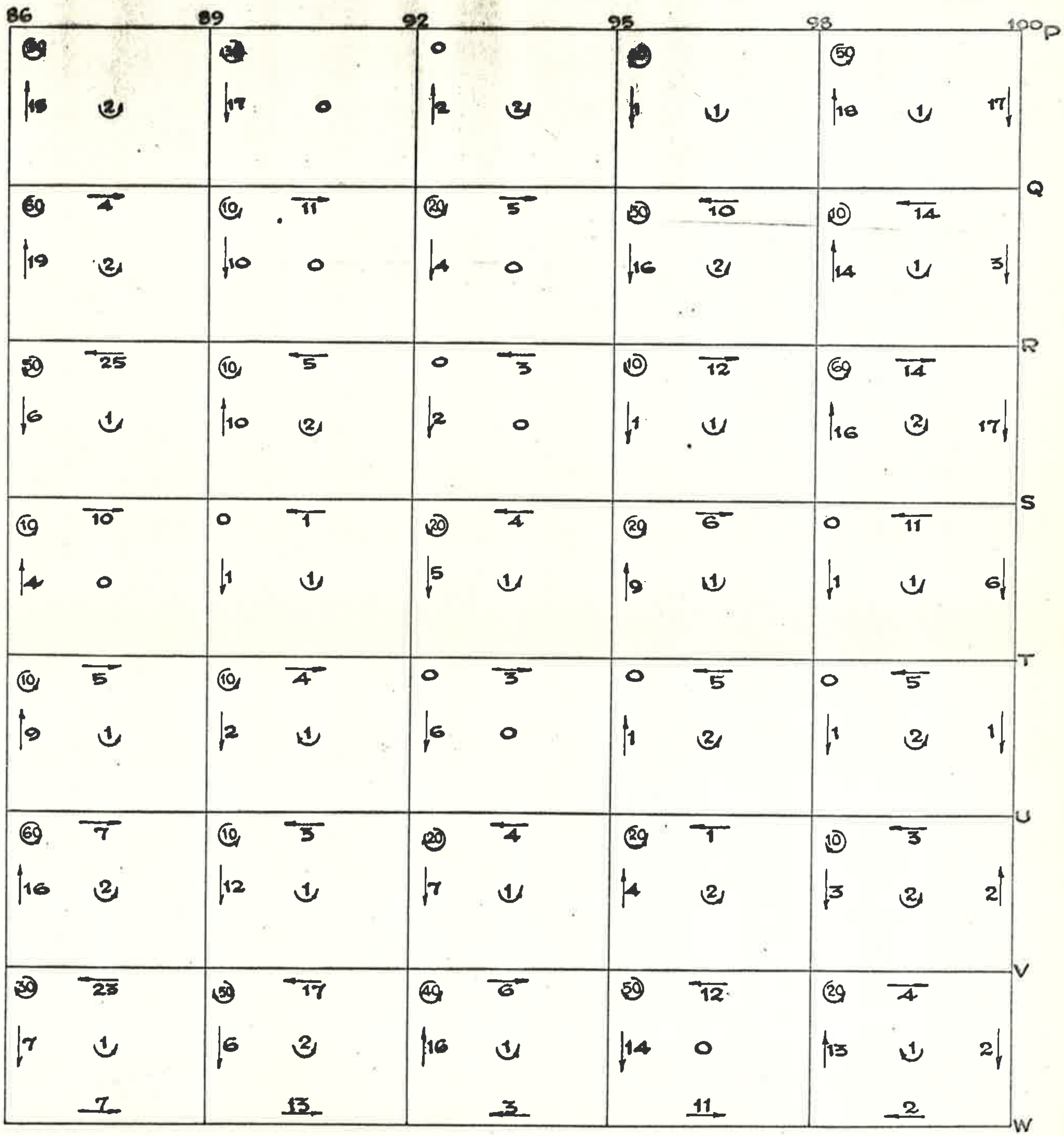
(3) Remaining Error in each Block.

PLATE 2.

Northern Area.

AHGL Mascot.

LEAST SQUARES CORRECTIONS



30 Original Closing Area in Gammas x10.

3 Remaining Error in each Block.

PLATE 2.

Southern Area

AHGL Mascot.

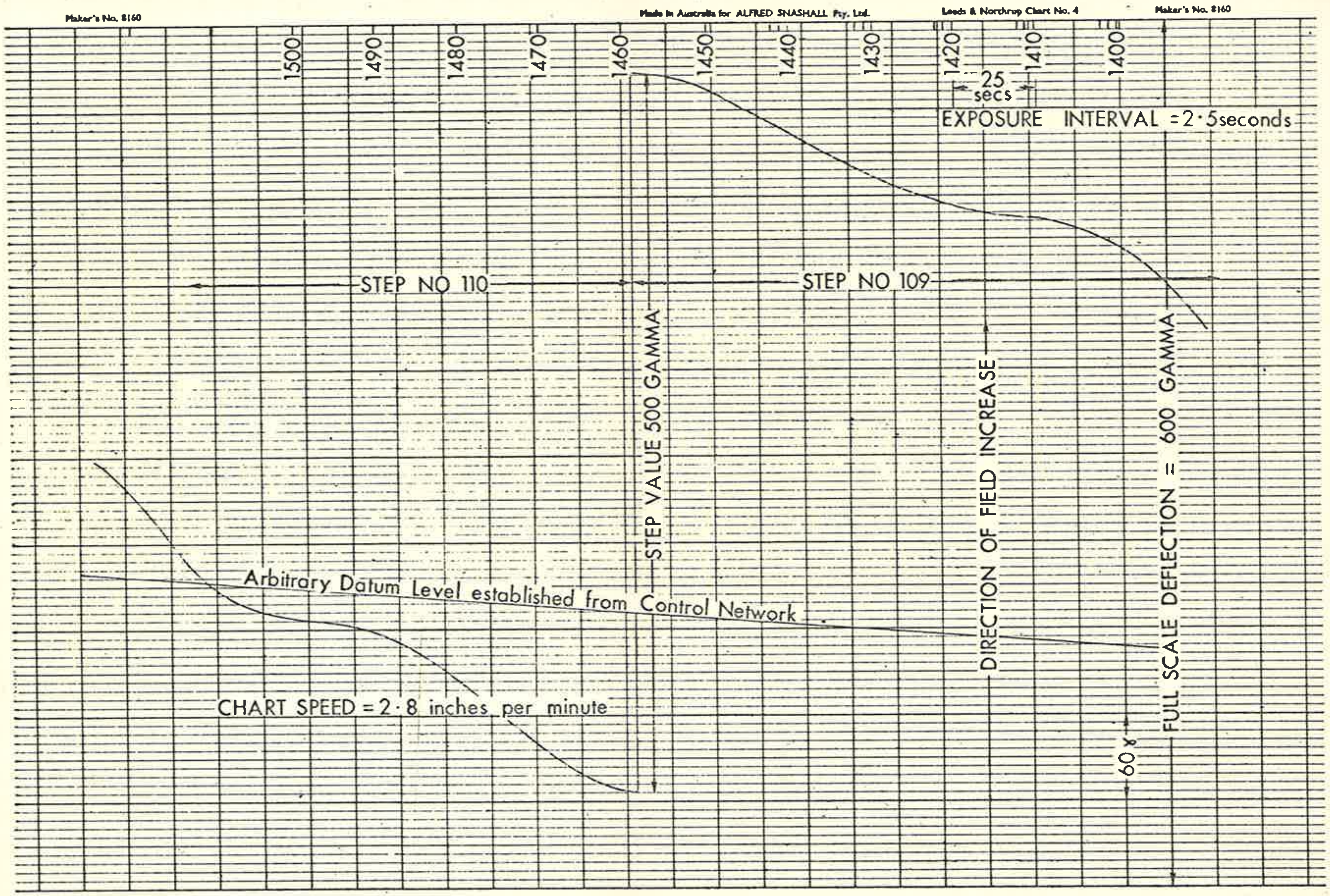


PLATE 3 SPECIMEN MAGNETOMETER RECORD

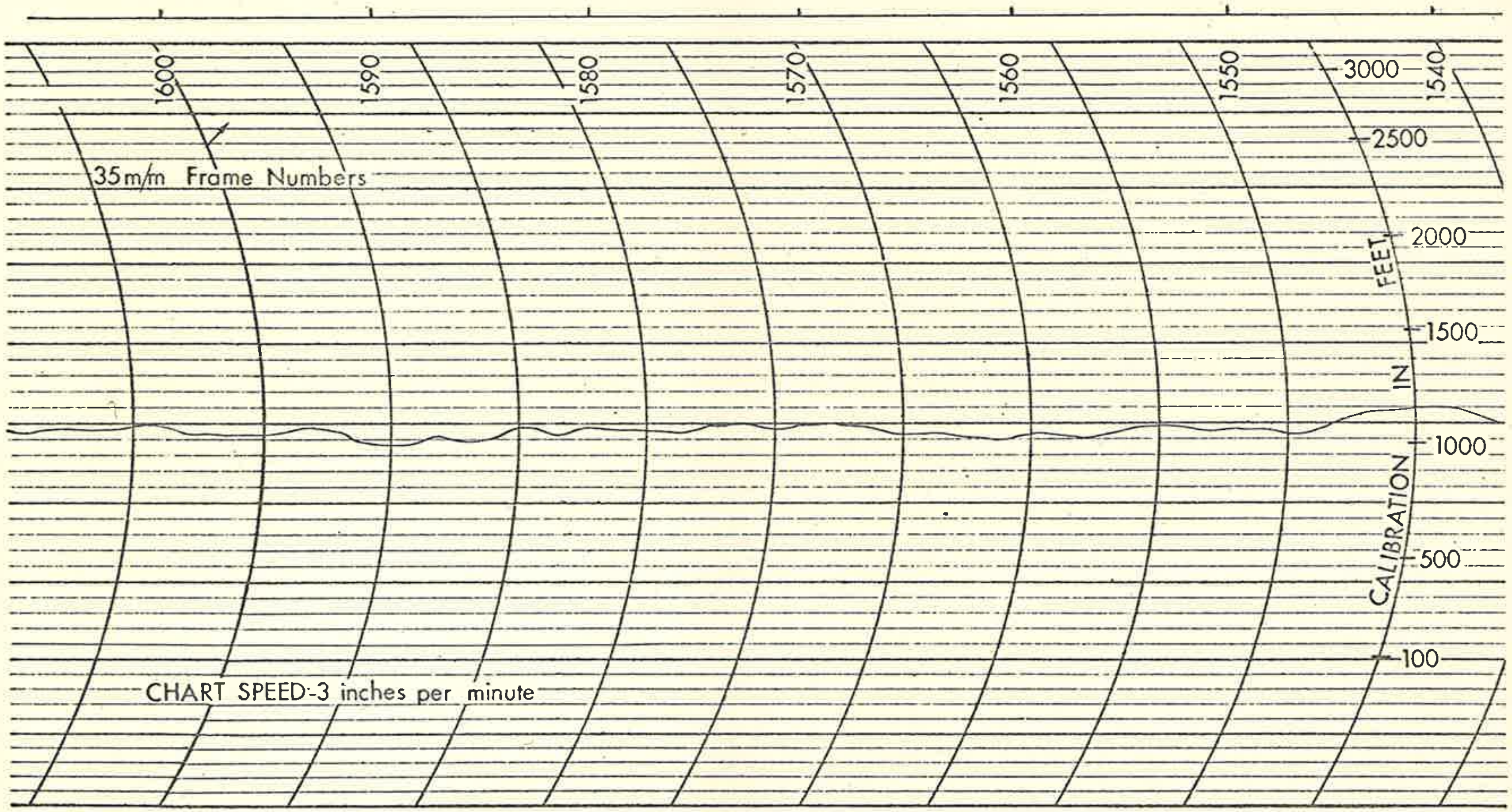


PLATE 4

SPECIMEN
RADIO ALTIMETER RECORD (curvilinear)

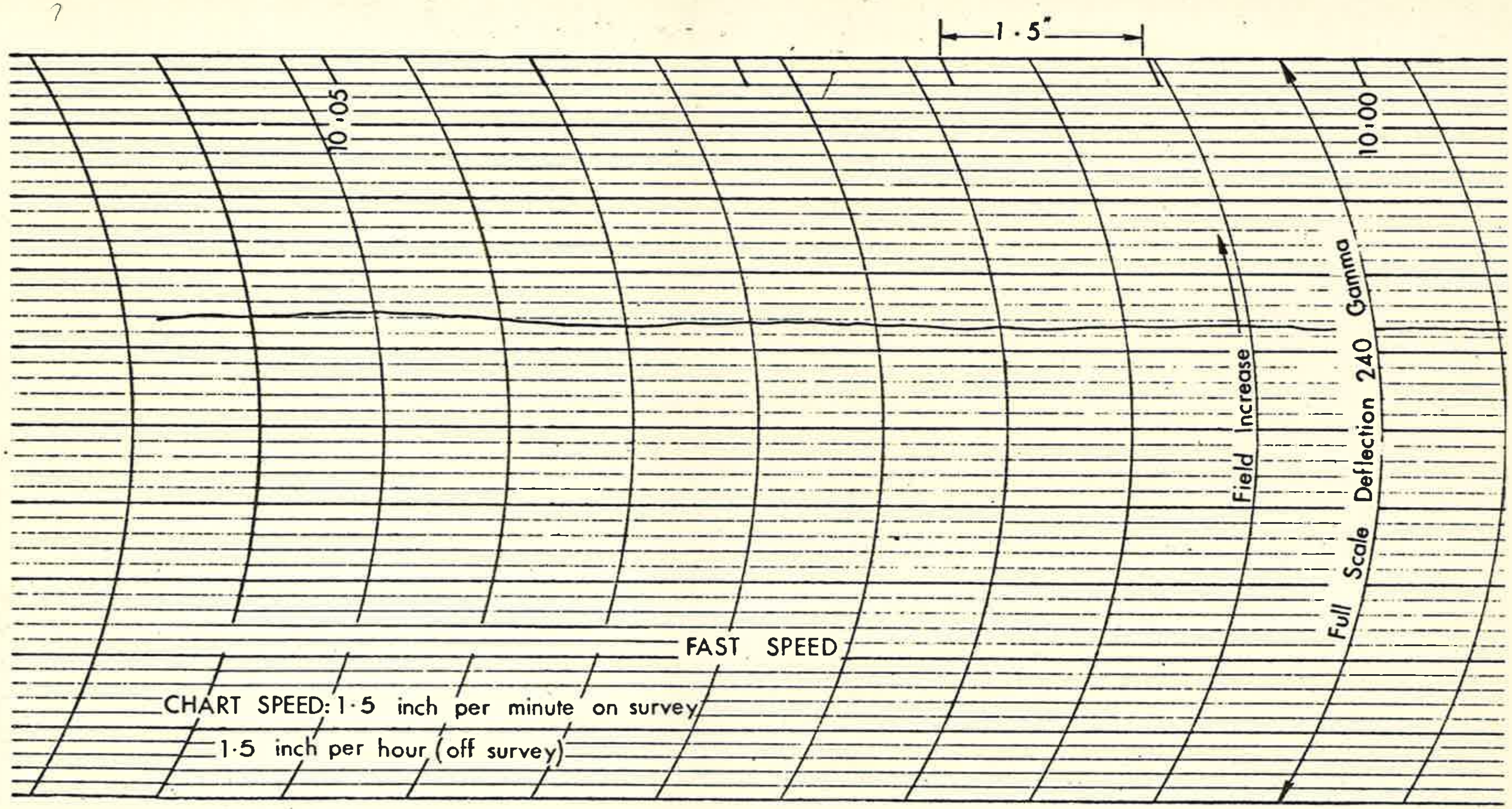


PLATE 5

SPECIMEN STORM MONITOR RECORD

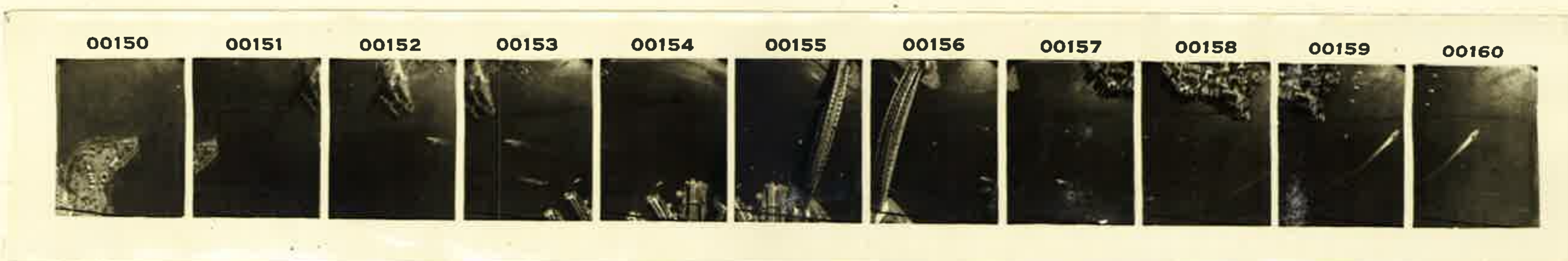
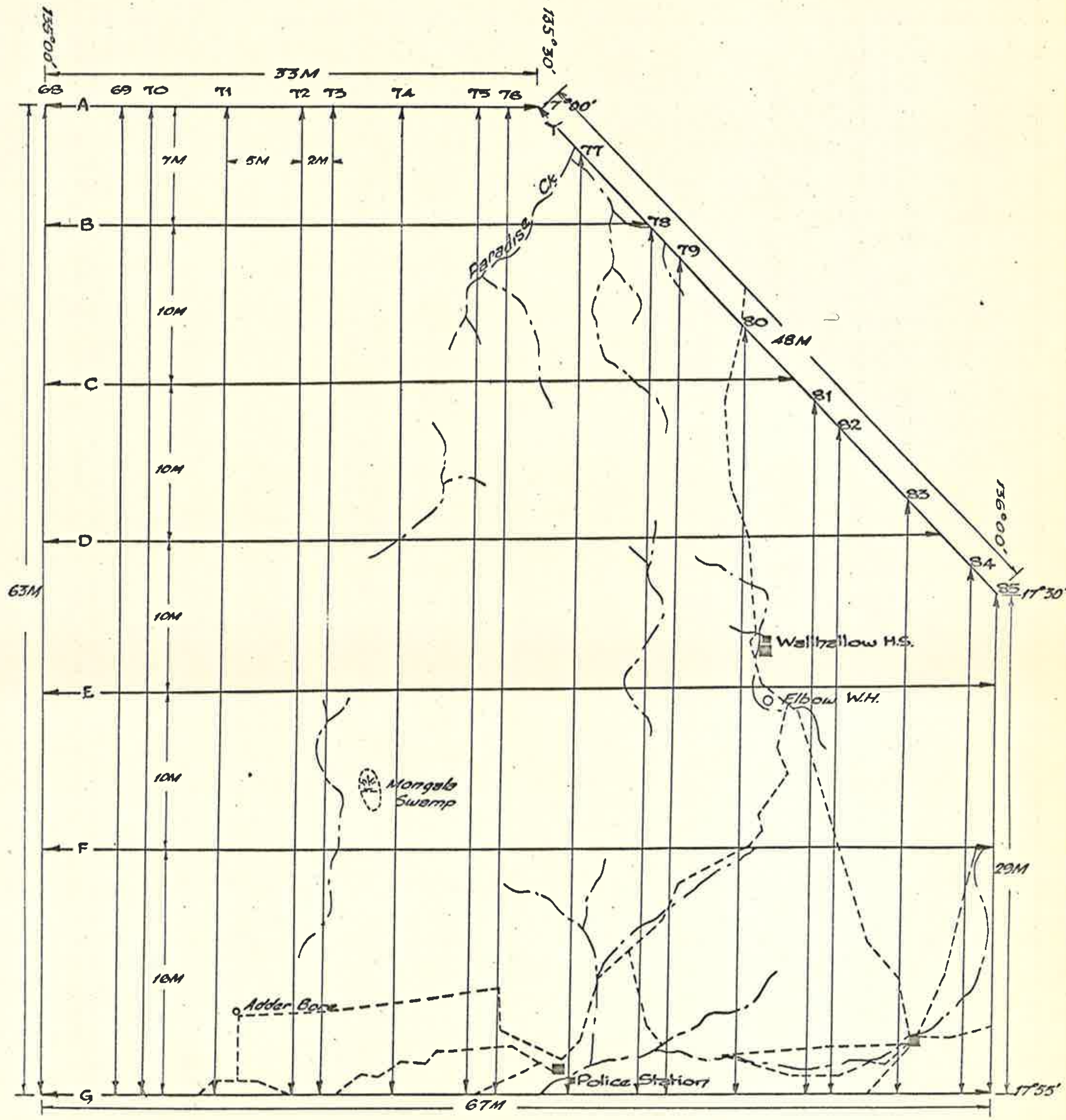


PLATE 6

SPECIMEN 35mm. STRIP FILM
(Restricted Photo)

~ WALLHALLOW AEROMAGNETIC SURVEY 1963 ~



TOTAL E-W LINE MILES = 434
TOTAL N-S LINE MILES = 964
1398

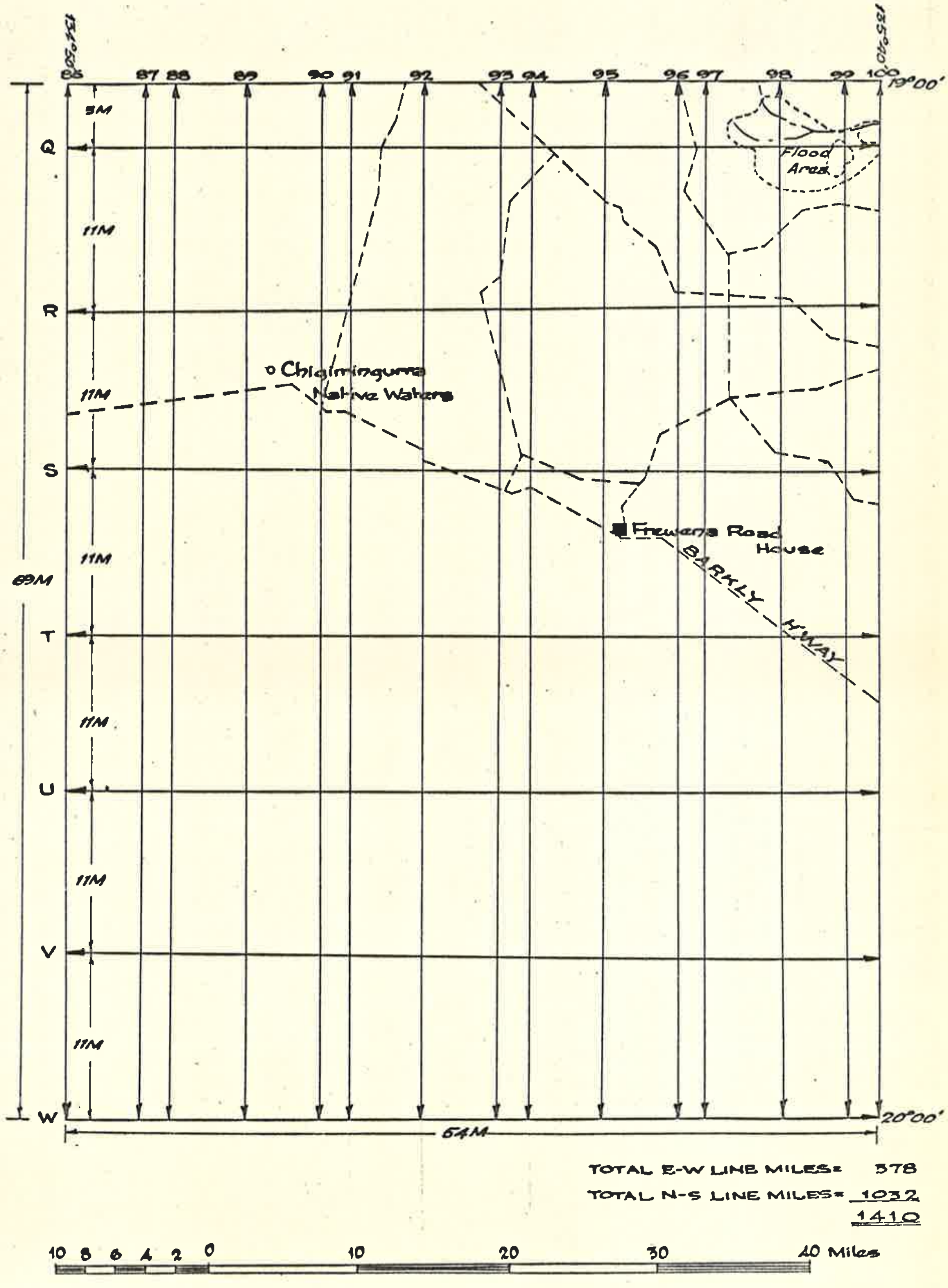
10 8 6 4 2 0 10 20 30 40 Miles

AHGL MASCOT

~ FLIGHT PLAN ~

PLATE 7.

~ ALROY AEROMAGNETIC SURVEY 1963 ~



AHGL MASCOT

~ FLIGHT PLAN ~

PART II

INTERPRETATION REPORT

LIST OF CONTENTS

I KNOWN GEOLOGY

I. 1 INTRODUCTION

The Wallhallow, OP73(i), and Alroy aeromagnetic surveys for Barkley Oil Company Pty. Ltd., and the Brunette Downs, OP67, aeromagnetic survey for Mines Administration Pty. Ltd. were flown as a continuous survey. The interpretation of these surveys was carried out as a single project although the results therefrom are presented as separate reports.

I. 2 GENERAL GEOLOGICAL SETTING

The Tectonic Map of Australia (Ref.1) shows that the combined survey area extends diagonally across the north-westerly trending Georgina Basin. The northeasternmost parts of the Wallhallow and Brunette Downs Surveys barely reach the western outcropping limits of the upper Upper Proterozoic McArthur River Basin whereas the southwesternmost corner of the Alroy Survey is at or near the boundary of the lower Lower Proterozoic rocks of the Warramunga Geosyncline. However, to the northwest and to the southeast, the lower Lower Proterozoic rocks are overlain by upper Lower Proterozoic rocks which extend to within 6 or 7 miles of the southwestern corner of the Brunette Downs Survey, and which outcrop within the Georgina Basin proper just south of the south central boundary of the Alroy Survey. The upper Lower Proterozoic rocks are not recognized to the northeast of the Georgina Basin as the upper Upper Proterozoic rocks of the McArthur River Basin are seen to lap against lower Lower Proterozoic rocks to the south and to the east of the South Nicholson Basin. Thus, it is evident that the Proterozoic rocks form the basement of the

Georgina Basin although the distribution and extent of the individual divisions are not known.

The rocks within the Georgina Basin are mapped as Lower Palaeozoic (Cambrian) overlain by a thin, discontinuous veneer of Mesozoic (Cretaceous) and Cainozoic (Tertiary and Quaternary) material.

I. 3 LOWER LOWER PROTEROZOIC

The Notes accompanying the Tectonic Map of Australia (Ref.1) describe the lower Lower Proterozoic rocks (Agicondian System) of the Warramunga Geosyncline as an assemblage of fine to medium grained greywacke including siltstone and shale of unknown thickness. Most of the structures trend east-west or northwest-southeast and consist of faulting and moderate folding. Large masses of porphyritic granite and numerous small porphyritic plugs and dikes have caused slight hornfelsing of the sediments around their contacts.

I. 4 UPPER LOWER PROTEROZOIC

The upper Lower Proterozoic rocks (Davenportian System) in the Davenport and Murchison Ranges to the south of Tennant Creek, consist mainly of a greywacke assemblage with minor acid and intermediate volcanic rocks, at least 20,000 feet thick. Folding with northwesterly axes gave rise to small basins and domes or broad, closed synclines and anticlines. Dips range from 60° to vertical with some beds overturned. Major faulting, in apparently two periods, occurred in northwesterly and north-easterly directions. These rocks are intruded by basic sills, by porphyries and by granites. In the Ashburton Ranges to the north of Tennant Creek, the rocks are mainly arenites with some associated volcanics, with a total thickness exceeding 11,000 feet. The main structural trend is northwesterly with a subsidiary northerly trend.

I. 5 UPPER UPPER PROTEROZOIC

The upper Upper Proterozoic rocks were deposited in a large composite structure (the McArthur River Basin) which was affected throughout its development by strong but spasmodic vertical movements (up to 13,000 feet). These movements resulted in the formation of sub-basins and in sharp variations in the thickness and in the lithology of the sediments. Three main assemblages have been recognized with one regional unconformity.

The first rocks deposited are a sequence of medium to coarse grained sediments and volcanics varying in thickness from a few hundred feet, to 12,000 feet in the McArthur River Area. Field work since the printing of the Tectonic Map of Australia indicates that this sequence should be classified with the lower Upper Proterozoic not recognized otherwise in this region.

The second sequence is essentially a carbonate assemblage composed of dolomite and calcareous lutite, chert, marl, minor volcanic rocks and arenites. It is thickest (14,000 feet) in the McArthur River Area.

The carbonate sequence was fallowed by widespread and severe vertical movements which caused the development of new basins of sedimentation such as the South Nicholson and the Maiwok Basins, to the east and north, respectively, of the combined survey area. The new sediments are mainly fine to medium grained arenites, with some minor volcanics and dolomites, up to 10,000 feet thick.

I. 6 PALAEOZOIC

Lower to Middle Cambrian rocks consisting mainly of flat-lying medium to coarse grained arenites, unconformably overlie the Proterozoic rocks in the northeastern part of the combined survey area. These rocks have been identified only since the printing of the Tectonic Map of Australia on which they are shown as part of the upper Upper Proterozoic. About 2,000 feet thick, they form a broad plateau of flat lying or very gently dipping rocks. Elsewhere, basalts and pyroclastic rocks were extruded.

Middle Cambrian sedimentation consisting of massive limestone and sandstone approximately 1,000 feet thick, were deposited in the Georgina Basin. This sequence may be replaced in some parts of the survey area by the arenite and plateau basalt sequence.

I. 7 MESOSOIC

Fairly extensive but probably thin siltstones and sandstones of Cretaceous age overlie the Cambrian sediments mainly in the northern part of the combined survey area.

I. 8 CAINOZOIC

Thin outliers of Tertiary limestones cover limited areas in central, south central and southeastern Brunette Downs Survey area and in northeastern Alroy Survey area. Elsewhere, Quaternary alluvium, soil, rubble, etc., form the surface deposits.

I. 9 BORE HOLES

A number of water bore holes have been sunk throughout the survey area, but all are shallow and none are recognized as having reached basement.

I. 10 OTHER GEOPHYSICAL DATA

A regional gravity profile is reported to have been run along the Barkley Highway but the results are not available to the writer.

I. 11 STRATIGRAPHIC SECTIONS

The stratigraphic sections to be expected for OP73(i) (Wallhallow) and for OP73(ii) (Alroy) are presented as Tables 1 and 2, on the next pages of the report. These sections are according to B.F. Fitzpatrick (Ref.2), Consulting Geologist to Barkley Oil Company Pty. Ltd. who made the report available to the writer.

Table 1 : EXPECTED STRATIGRAPHIC SECTION

Wallhallow Aeromagnetic Survey, OP73(i)
(According to B.F. Fitzpatrick, Ref.2)

CAINOZOIC:	Quaternary:	-Alluvium, residual soil, sand, residual black soil, laterite and laterite rubble.
MESOZOIC:	Lower Cretaceous:	-Massive grey calcareous siltstone, white leached siltstone, massive white quartz sandstone with plant remains.
PALAEOZOIC:	Cambrian:	-Anthony Lagoon Beds : Massive buff limestone, massive grey calcareous sandstone, chert.
	Lower Cambrian:	-Top Springs Limestone : Massive, grey to buff limestone, some algae. -Bukalana Sandstone : Massive, jointed, medium buff feldspathic sandstone.
PRECAMBRIAN:	Upper Proterozoic:	ROPER GROUP: -Abner Sandstone. -Arnold Sandstone Member : Massive, white, jointed, medium coarse quartz sandstone. -Crawford Formation : Blocky glouconitic sandstone, flaggy, purple mic. sandstone. -Mainoru Formation : Flaggy, purple mic. siltstone and fine sandstone. -Limmen Sandstone : Blocky med. qtz. sandstone, conglomerate. McARTHUR GROUP: -Billengarah Formation : Blocky qtz. sandstone, chert, siltstone, dolomite. -Emmerugga Dolomite : Massive fine dolomite, interbedded dolomite, algae dolomite, flaggy dolomitic siltstone, flaggy fine sandstone. -Tooganinie Formation : Alternating dolomite, algal dolomite, purple siltstone, qtz. sandstone, minor sandy dolomite, oolotic dolomite. -Leila Sandstone Member : Flaggy medium qtz. sandstone, coarse dolomitic sandstone and sandy dolomite. -Tatoola Sandstone : Flaggy purple to white medium sandstone and dolomitic sandstone, minor siltstone and sandy dolomite. -Amelia Dolomite : Flaggy silty dolomite, massive dolomite and algal dolomite, minor fissile green siltstone, oolitic dolomite.

-Mallapunyah Formation : Purple siltstone, med. qtz sandstone dolomite, sandy dolomite, algal dolomite, oolitic dolomite, chert.

TAWALLAH GROUP:

-Masterton Formation : Flaggy to blocky, pink to purple med. qtz sandstone and feldspathic sandstone, flaggy friable fine ferruginous sandstone.

-Wollogorang Formation : Flaggy purple and grey dolomite, dolomite siltstone, dolomitic sandstone, sandy dolomite and ferruginous sandstone.

-Settlement Creek Volcanics : Basalt, minor tuff and tuffaceous siltstone.

-Sly Creek Sandstone : Massive to flaggy pink and purple brown med. qtz sandstone.

-McDermott Formation : Flaggy purple dolomite and dolomitic siltstone.

-Peters Creek Volcanics : Basalt.

-Westmoreland Conglomerate : Blocky med. qtz sandstone, feldspathic sandstone, silicified sandstone.

Table 2 : EXPECTED STRATIGRAPHIC SECTION

Alroy Aeromagnetic Survey, OP73(ii)

(According to B.F. Fitzpatrick, Ref.2)

CAINOZOIC:		Black soil, sand, travertine, laterite, Brunette Limestone.
MESOZOIC:		Undifferentiated due to leaching etc.
PALAEOZOIC:	Middle Cambrian :	-Wonarah Beds. -Anthony Lagoon Beds. -Top Springs Beds.
PROTEROZOIC:		Mittiebah Sandstone.

II METHODS OF INTERPRETATION

II. 1 QUANTITATIVE ANALYSES OF ANOMALIES

The quantitative analyses summarized in the Appendix of Part II of this report and on the accompanying maps, wherever possible were carried out directly from the magnetometer records with due allowance for the direction of flight with respect to the anomaly and for the scale of the tapes. The elevation of the causative body was referred to mean sea level by subtracting the calculated depth below aircraft from the aircraft altitude.

The various methods and their basic assumptions used in the present interpretation are described in the following paragraphs. The letter in parentheses after the name of the method is the symbol used in the Appendix of Part II of this report to identify the method used.

(a) Dipping Dike Method (D) :

Using the inflection points and their slopes, and the maximum or minimum of a perpendicular profile across a dike-like body, the depth, width, dip, location and magnetic susceptibility contrast of that body can be calculated by referring to appropriate charts and tables. The method, under certain circumstances, may give reasonable answers from an anomaly which is not caused by a dike-like body. However, certain checks (such as maximum to the north or south of the minimum, etc.) are provided by the method and help in detecting these instances. On the other hand, if the method does not work on a given anomaly, the anomaly is not caused by a dike-like body or it is disturbed by the effects of adjacent bodies and their anomalies, or by an undetected or misinterpreted regional gradient.

The elevation obtained by this method is plotted on the accompanying maps at the calculated centre of the dike-like body.

This method was developed by personnel of Hunting Survey Corporation Ltd. of Toronto, Canada. Although a paper is in preparation, the method as yet is not published and no reference can be given.

(b) Peters' Method of Continuation (P) :

This method, published by Peters (Ref.3), involves a continuation of the observed anomaly from the elevation of flight or observation down to an arbitrary depth, followed by a continuation upwards to the original elevation. There will be a slight difference or error between the observed anomaly and that which is continued downwards and then upwards. This error is due mainly to the inherent inaccuracies in the continuation process. However, if the depth of continuation becomes equal to, or greater than, the depth to the magnetic body, the continuation process is not valid and the error tends to increase appreciably. An error curve is obtained by repeating the continuation process for a number of increasing depths and plotting the resultant errors against the corresponding depths. The slope of the curve is relatively small for shallow depths and increases suddenly to large values where the depth of continuation becomes equal to that of the causative body. The point at which this occurs is disturbed or complex anomalies which otherwise would not respond to other methods.

The depth obtained by this method is plotted half-way between the two inflection points of the anomaly. In some cases where depths are obtained on adjacent, closely spaced lines over a single body, the results are averaged and plotted centrally on the interpreted and interpolated trend of this body.

(d) Step Anomaly :

A peculiar feature of this survey is arbitrarily called the Step Anomaly in this report. It consists of a change of a few gammas up to 100 gammas, in the regional value of the magnetic field. This change occurs over a relatively short distance, is often traced over very large distances from line to line, is superimposed on the regional gradient which remains constant, and is similar in profile, to an arctangent curve although often distorted. Thus, the profile is characterized by the fact that there is only one inflection point. This characteristic can be difficult to recognise where another anomaly is close by and therefore, it is probable that this type of anomaly is often overlooked and even mis-interpreted on profiles showing fair magnetic relief.

Although encountered elsewhere in the writer's experience, these step anomalies have never been satisfactorily explained from a mathematical and physical point of view. Thus, it is not possible to devise a proper and accurate method of quantitative analysis. However, the Half-Slope Method can give approximately correct depths from anomalies caused by bodies other than dike-like. Thus, the Half-Slope Method was applied called the "break-point" and indicates the depth of the causative body.

The actual process of continuation is very similar to the familiar method of obtaining second vertical derivatives of the magnetic field : it consists of obtaining the average of the magnetic intensity on a given number of concentric circles. The properly weighted sum of the averages provides the "continued" value of the field at the centre of the circles. The location of the centre of the circles is not critical generally but for better results (sharper break-point), it is usually chosen at or near the maximum variation in the horizontal gradient of the anomaly. On the accompanying maps, an elevation obtained by this method is plotted at the chosen centre.

(c) Half-Slope Method (S) :

The points of half-maximum slope are empirically related by Peters (Ref.3) to the depth of a dike-like body so orientated in space that it produces a symmetrical anomaly. Where the anomaly is not quite symmetrical, the two flanks of the anomaly are processed independently and the results are averaged. A refinement to the method consists in varying the empirical factor to allow for variations in the width to depth ratios of the various anomalies. Despite this refinement, this is still a rule of thumb which can be in severe error when applied to anomalies which are too disturbed, too asymmetrical, too complex (the summation of two or more anomalies) or not dike-like. However, the method presents a number of advantages such as speed, ease to use and, especially, its applicability on in a few instances where the Step Anomaly appeared undisturbed and similar to one flank of a wide, symmetrical, dike-like anomaly. Unfortunately, the results must be considered to be approximate only, if not rather doubtful.

The recognized Step Anomalies are shown on the accompanying maps by a heavy line through their single inflection point. A "plus" (+) sign is used to identify the side with the increase in magnetic value, and conversely, a "minus" (-) sign for the side with the decrease in value. The few elevations obtained by the Half-Slope Method are plotted at the inflection point, that is, at the intersection of the heavy line just described and the flight-line. Where depths are obtained on adjacent, closely spaced lines over the same anomaly, the results are averaged and plotted centrally on the interpolated trend of the anomaly.

(e) <u>Accuracy and Grade of the Quantitative Analyses</u> :

Generally, results of quantitative analyses based on aeromagnetic data are considered to be accurate to 20% or better of the total depth. In the present surveys, a large number of the anomalies analysed are too weak and/or too complex to be submitted to the more accurate methods. Thus, the greater proportion of the analyses was carried out by the Half-Slope Method, and a fair percentage of these, owing mainly to the asymmetry of the anomalies, show a possible range of results slightly greater than the usual 20% of the total depth. Thus, the estimated grades are based on the expected maximum possible error.

Grade "A" (Good) signifies that the expected error is appreciably less than 20% as the anomaly is well defined, undisturbed, and that an accurate method was applied successfully. In the present surveys, this grade is possible only in the case of results obtained by the Dipping Dike Method.

Grade "B" (Fair) signifies that the expected error may be as great as, but not more than, 20% of the total depth. This is the case where methods less accurate than the Dipping Dike Method are used such as Peters' Method of Continuation and the Half-Slope Method. In the case of the former, this is due to the rather indefinite nature of the break-point. In the case of the latter, only a minority of the results warrant this grade where they are obtained on fairly symmetrical and undisturbed anomalies.

The majority of the Half-Slope results are attributed Grade "C" (Poor) where the expected error is less than 30% but is not necessarily less than 20%. This is due generally to marked asymmetry, disturbance or complexity on the part of the anomaly. Peters' Method of Continuation may also be ascribed this grade where the break-point is poorly defined.

The results of certain quantitative analysis are questioned (Grade "?") where the anomalies are so disturbed, so complex or so weak that the error could be, but is not necessarily, greater than 30%. It is felt that most of the questionable results are as valid as those of Grade "C" although this belief could be proved to be wrong in some cases. The results based on the Step Anomaly as discussed in previous paragraphs must, perforce, be attributed this grade.

The estimated grades are shown immediately following the elevations on the accompanying Basement Maps and are tabulated in the Appendix of Part II of this report. In the same Appendix, the value of 20% of the total depth from aircraft is also tabulated as a guide, when combined with the estimated grade, towards the expected accuracy of the analysis.

II. 2 GEOLOGICAL AND STRUCTURAL INTERPRETATION

The qualitative interpretation of the geology and structure of the survey areas is based on all available data, viz., the quantitative analyses of the anomalies and the geological and other information summarised in Chapter I of Part II of this report.

II. 3 PRESENTATION OF THE INTERPRETATION

The results of the interpretation of the Wallhallow and Alroy Aeromagnetic Surveys are presented in the form of two sets of transparent overlays as per Subsidy Act requirements at a scale of 1 inch to 4 miles. One set of overlays is titled Basement Map, showing the calculated elevations and contours of the magnetic basement. The second set of overlays is titled Interpretation Map and shows the qualitative results of the geological and structural interpretation.

By the individual juxtaposition of the Basement and Interpretation Maps over the Total Magnetic Intensity transparencies, prints showing the results of the interpretation on a magnetic contour background were prepared and one set of these maps is enclosed in the map-pocket inside the front cover of this report.

and to their scattered distribution.

III. 2 BASEMENT MAPS

(a) Sheet 1, Wallhallow Survey :

A total of 224 attempts at quantitative analysis of suitable anomalous conditions resulted in 185 acceptable results grouped into 93 magnetic basement elevations numbered 1 to 93 on the accompanying maps. Eighty-nine of these elevations are based on the Half-Slope Method only; four values are obtained by the Dipping Dike Method and are checked by at least one Half-Slope determination. The elevations are graded as follows: 3 of Grade "A", 11 of Grade "B", 56 of Grade "C" and 23 of Grade "?".

The magnetic basement defined by these depth determinations is seen as a relatively shallow, gently undulating surface. At, or near, surface in the east central part of the survey area, it slopes westwards to a depth of some 1,000 feet below sea level in the western half of the map sheet. The deeper portion or basin is bounded by a broad ridge or high at about 500 feet below sea level, trending east-northeasterly along the southern boundary of the survey. A slight southwesterly plunging ridge may separate the northwesternmost corner of the area from the main basin.

The deepest part of the main basin is not clearly defined mainly because of the lack of suitable depths. Thus, in the northern part of the basin, Nos. 18, 62 and 64 indicate relatively dependable depths of 1,000 to 1,200 feet below sea level. Farther south, no suitable anomalous conditions could be found until the highly questionable determinations 66, 67 and 73 are reached with depths (most probably too deep) up to 2,500 feet below sea level. No. 68 (7,600 feet below sea level) is clearly a large intrabasement feature on the basis of the superimposed, shallower trends. Finally, a sharp localized high within the basin is indicated by 63 (460 feet above sea level) : the ring-shaped anomaly is indicative of a contact metamorphic zone around a small intrusive plug which may have reached into the overlying section or may have left a sharp erosional high. No. 65 (1,820 feet below sea level) is based on a similar but less intense anomalous condition : the much greater depth of this second intrusive plug indicates that it may well not have reached the basement surface and therefore, that it cannot be considered a dependable indication of the basement elevation at this point.

The magnetic basement is correlated with the Proterozoic-Palaeozoic unconformity, that is, with the geological basement. This is supported by the surface or near surface elevations of the magnetic basement in the east central part of the area in the vicinity of outcropping upper Upper Proterozoic rocks. The geological considerations presented in Section 3 of this chapter also tend to confirm this correlation.

(b) Sheet 2, Alroy Survey :

A total of 68 attempts at quantitative analysis of suitable anomalous conditions resulted in 59 acceptable depths which are grouped into 51 depths numbered 1 to 51 on the accompanying maps. Forty-four of these elevations are based on the Half-Slope Method only; five values are obtained by the Dipping Dike Method and checked by at least one Half-Slope determination; Peters' Method of Continuation provided two depths to large, evidently intrabasement features. The elevations are graded as follows : 4 of Grade "A", 8 of Grade "B", 18 of Grade "C" and 21 of Grade "?".

The magnetic basement defined by these depth determinations is a rather irregular surface. In the southern half of the survey area, its elevation varies between 700 feet above to some 1,000 feet below sea level although a good portion is actually above sea level. No basin of any consequence is defined.

In the northwestern quarter of the area, the few scattered depths suggest a somewhat flatter basement at depths of 500 to 1,000 feet below sea level.

Underlying roughly the northeastern quarter of the survey area, a relatively sharp-edged basin reaches a depth of some 3,000 feet below sea level, and is the deepest basin detected within the Alroy-Wallhallow aeromagnetic survey. It starts quite abruptly in the centre of the Alroy survey area and extends roughly northeastwards beyond the eastern boundary of the map sheet. Its presence is well established by two Grade "B" and a number of Grade "C" determinations.

Two depths are marked as intrabasement features on the accompanying maps. Nos. 3 and 5, with depths of 9,200 and 12,400 feet below sea level respectively, are clearly not related to the magnetic basement as contoured.

The magnetic basement is correlated with the erosional surface composed of Lower Proterozoic rocks. This is supported by the very shallow depths obtained over a small north-south ridge which appears to trend towards the reported outcrop of upper Lower Proterozoic just south of the south central boundary of the survey area (Ref.1). Geological considerations presented in Section 3 of this chapter also support this general correlation. However, these same considerations also point out the possibility that the northeast basin could contain some unknown thickness of unconformable upper Upper Proterozoic rocks which remained undetectable by the aeromagnetic survey. Although this possibility appears remote considering the magnetic response of similar rocks in Sheet 1 (Wallhallow Survey), it cannot be altogether neglected as it could seriously detract from the general correlation of the magnetic basement with the geological basement sought, that is, the Proterozoic-Palaeozoic unconformity.

III. 3 INTERPRETATION MAPS

(a) Sheet 1, Wallhallow Survey :

This survey shows a large number of weak anomalies which give rise to the depth determinations defining the magnetic basement. As discussed in the Introduction to this chapter (Section III. 1), they appear to form long, fairly continuous, parallel to sub-parallel trends. As shown on the Interpretation Map, these trends are typical of bedded rocks. The calculated magnetic susceptibility contrasts varying between 0.000,1 and 0.000,8, and averaging 0.000,3 c.g.s. units, indicate a very low magnetite content. The few calculated dips and other qualitative considerations indicate fairly flat-lying strata to the north and northeast, steepening somewhat to the south. Coupled with the shallow depths in the northwestern part of the area, these observations suggest that the magnetic basement is composed of the arenites and minor metamorphism around the less magnetic plugs, or, less likely, magmatic differentiation within the intrusive body. The composition on the intrusive in the first instance, is probably quite acid (granite or similar material) being non-magnetic, whereas in the second instance, it could be basic or even ultra-basic with the magnetite differentiated to its outer portions.

The intruded rocks indicate that these plugs are upper Upper Proterozoic in age, or younger. However, 63 causes a definite and sharp magnetic basement high as discussed in Section III.2(a). Thus, two possibilities present themselves, one as probable as the other : firstly, the intrusive 63 is as young as, or younger than, Cambrian in age having intruded the overlying section; secondly, it is late upper Upper Proterozoic in age and left an erosional high on the magnetic basement surface. In the case of 65, the same age considerations apply mainly because of its physical similarity to 63 although it does not appear to have reached the basement surface.

(b) Sheet 2, Alroy Survey :

The magnetic relief encountered within Sheet 2 (Alroy Survey) presents a very different picture to that of Sheet 1 (Wallhallow Survey) : anomalies similar to the magnetic bedding trends are very few in the southern map sheet whereas anomalies usually associated with intrusive masses are quite numerous. Considering the geological description of the surrounding basement outcrop areas (Chapter I of Part II of this report), it is evident that the magnetic picture is more apt to describe the intrusive activity which is common in the Lower Proterozoic and which is absent in the Upper Proterozoic. Furthermore, the magnetic basement is shown to form a very shallow ridge at the south central boundary of the survey area, that is, in the vicinity of reported upper Lower Proterozoic outcropping within the Georgina Basin (Ref.1). Thus, it would appear that the magnetic basement is composed of these rocks although it is possible that some lower Lower Proterozoic rocks may also be present and undistinguishable magnetically.

The above correlation of the magnetic basement is based on the assumption that the Upper Proterozoic rocks of Sheet 1 would have the same magnetic characteristics if they were present in Sheet 2. This is a logical assumption on the basis of the available data although it is not necessarily correct. Thus, it is possible that the Lower Proterozoic basement is overlain by a generally thin, insignificant and magnetically undetected layer of Upper Proterozoic sediments which could become significantly thick in the deep basin in the northeastern quarter of the area. Although considered at present to be remote on the basis of the basement outcrops to the east and to the south of the area, this possibility cannot be overlooked altogether especially when it is considered that the relatively sharp-edged basin could be very similar, structurally, to the known sub-basins of Upper Proterozoic age.

The calculated susceptibility contrasts of the few interpreted bedding trends vary between 0.000,2 and 0.002,4 c.g.s. units although most of them are less than 0.000,8 c.g.s. units. It is possible that the trends with the higher contrasts are indicative of volcanic rocks or even intrusive sills with narrow widths. This is particularly the case of trend 35-35 parts of 12, imply only a low susceptibility contrast which could occur across a possibly very significant fault.

The interpreted intrusions and faults have no detectable effect on the basement surface convolutions. Thus, it would appear that these features are older than Cambrian but younger than the Lower Proterozoic rocks in which they are found.

To avoid possible confusion, intrabasement features 3 and 5 with depths of 9,200 and 12,400 feet below sea level respectively, are not outlined on the Interpretation Map. Their contacts are difficult to locate accurately and would be of academic interest only. The magnetic susceptibility contrasts were not calculated but are estimated to be in the order of 0.005 c.g.s. units or greater, indicative of fairly basic intrusions or highly metamorphosed rocks, possibly representative of the Archean floor. This tentative correlation suggests that the Proterozoic rocks are present with an effective, but not necessarily true, thickness of 9,000 to 11,000 feet.

IV SUMMARY AND CONCLUSIONS

The interpretation of the Alroy-Wallhallow aeromagnetic survey shows that the magnetic basement surface presented on the contoured Basement Maps is generally correlated with the Proterozoic-Palaeozoic unconformity.

In Sheet 1 (Wallhallow Survey), the basement, composed of upper Upper Proterozoic rocks, is quite shallow over the north-eastern half of the area but deepens to a depth of some 1,000 feet below sea level in the western half. This basin is limited to the south by a near surface ridge but is open to the west and probably to the northwest.

In Sheet 2 (Alroy Survey), the basement is composed of upper Lower Proterozoic rocks and presents a rather irregular and shallow surface (generally above sea level) over the southern half of the area. The basement appears somewhat deeper (to 1,000 feet below sea level) and probably flatter in the northwestern quarter of the area whereas a deep, sharp-edged basin with depths of some 3,000 feet below sea level occupies the northeastern quarter and extends beyond the eastern boundary of the survey. However, there is a remote possibility that this deep basin could contain an unknown thickness of undetected upper Upper Proterozoic rocks which could reduce considerably its possible significance.

The interpreted structural and geological features within the basement consist mainly of broad folding and minor faulting in Sheet 1 (Wallhallow Survey), and intrusive activity and probably major faulting (Step Anomalies) in Sheet 2 (Alroy Survey). In both areas, these basement features have no detectable control over the basement surface convolutions and therefore should have no direct effect on the overlying Palaeozoic section. One exception to this statement is the small intrusive plug 63 in Sheet 1 which may have intruded the younger rocks.

Several intrabasement features at large depths, are intensely magnetic and may be indicative of the Archean floor. Their only significance lies in suggesting an effective thickness of the Proterozoic rocks of some 6,600 feet in southwestern Sheet 1, and of 9,000 to 11,000 feet in Sheet 2.

V RECOMMENDATIONS

The generally shallow basement indicated by the interpretation of the Alroy-Wallhallow aeromagnetic surveys would appear to limit the potentially favourable areas to the deep basin in northeastern Sheet 2 (Alroy Survey) and to the shallower but more extensive basin in eastern Sheet 1 (Wallhallow Survey).

On the basis of the available data, it is recommended that, if economically warranted, further exploration work should take the form of two or more test bores to the basement. One bore should be located in the deep basin of Sheet 2 (Alroy Survey) to establish once and for all the presence or absence of non-magnetic upper Upper Proterozoic rocks overlying the magnetic basement. The second bore should probe the shallower basin of western Sheet 1 (Wallhallow Survey). Both bores should determine whether or not potential source beds are present, probably below the limestone aquifer which is the target of the many water bore holes in the general area.

Favourable results from one or both bores would indicate the necessity of seismic work to locate potential traps within the appropriate area or areas. The seismic interpretation would also be greatly facilitated by the availability of proper logs from the bores.

Operations Report

by B.A. Howe
Aeromagnetics Manager

Interpretation Report

by C.W. Faessler
Senior Geophysicist.

VI REFERENCES

1. "Tectonic Map of Australia" and accompanying Geological Notes. Published by the Bureau of Mineral Resources, Geology and Geophysics; 1962.

2. Fitzpatrick, B.F. "A Review of the Geology of O.P. 73(1), (2) and (3), Northern Territory" Unpublished report to Barkley Oil Company Pty. Ltd.

3. Peters, Leo J. (1949) "The Direct Approach to Magnetic Interpretation and Its Practical Application"; Geophysics, Vol. XIV, No. 3.

VII APPENDIX

Summary of Quantitative Analyses

Alroy-Wallhallow Aeromagnetic Survey

<u>Summary of Quantitative Analyses</u>

<u>Alroy-Wallhallow Aeromagnetic Survey</u>

<u>Note</u> : The following quantities are tabulated :

-Reference number of the anomaly, depth determination, or body as used on the accompanying maps and in the report.

-Calculated elevation of the body, in feet above (+) or below (-) sea level.

-20% of the total depth from aircraft in feet, as a guide towards the maximum expected error as indicated by the estimated grade (See Section II-1(e) of Part II of the report).

-Grd : estimated grade (See Section II-1(e) of Part II of the report).

-Mthd : method of analyses used (See Section II-1(a to d) of Part II of the report).

-Magnetic susceptibility contrast in c.g.s. units.

-Abreviations under Remarks : Avg - average : FL - flight line ; TL - tie-line ; m - calculated half-width of dike-like body ; d - calculated dip of dike-like body ; Pro.Fact. - projection factor allowing for angle of intersection between line and anomaly.

No	Calc Elev	20% of Total Depth	Grd	Mthd	Magn. Susc. Contrast	Remarks
<u>Sheet 1, Wallhallow Survey</u> :						
1	-1,320	700	?	S	0.000,3	Pro.Fact. doubtful.
2	-620	560	C	S	0.000,2	Avg FL 71 and TL A.
3	-620	560	C	S	0.000,3	TL A only.
4	-1,350	710	?	S	0.000,2	Pro.Fact. doubtful.
5	-1,540	750	?	S	0.000,2	FL 70 only. Complex.
6	+310	380	C	S	0.000,2	FL 72 only. Its extent to FL73 is not definite.
7	+280	380	C	S	0.000,4	Avg FL 72 and TL B.
8	-700	580	?	S	0.000,2	Pro. Fact. doubtful.
9	-460	530	C	S	0.000,3	West end of long trend 9, 10,11,12.
10	-1,000	640	A	D	0.000,5	FL 69 : m=3100',d=35°S. Good check by S on FL69,70. Part of trend 9,10,11,12.
11	-850	610	B	S	0.000,3	Part of trend 9,10,11,12.
12	+190	400	C	S	0.000,2	East end of trend 9,10,11,12.

No	Calc Elev	20% of Total Depth	Grd	Mthd	Magn. Susc. Contrast	Remarks
13	-600	560	B	S	0.000,2	Good avg FL 68 and TL C.
14	-910	620	B	S	0.000,3	Good avg FL 69,70.
15	-1,620	760	?	S	0.000,3	Very asymmetrical or complex anomaly.
16	-600	560	C	S	0.000,1	Avg FL 69,70. Weak, complex anomaly.
17	-1,780	800	?	S	0.000,3	Complex anomaly.
18	-1,050	650	C	S	0.000,3	Avg FL 72,73.
19	-980	640	?	S	0.000,1	Pro.Fact. doubtful. Weak.
20	-50	450	C	S	0.000,4	FL 76 only.
21	-240	490	C	S	0.000,3	TL C only.
22	-280	500	C	S	0.000,1	FL 76 only. Weak, disturbed anomaly.
23	-1,000	640	?	S	0.000,3	Pro.Fact. doubtful. May join 24 or 25.
24	-440	530	?	S	0.000,2	Pro.Fact. doubtful.
25	+300	380	C	S	0.000,2	FL79 only, too weak on FL78 and TL Y.
26	-1,000	640	C	S	0.000,2	
27	-720	580	?	S	0.000,3	Pro.Fact. doubtful.
28	+200	400	?	S	0.000,1	Very weak.
29	+700	300	?	S	0.000,1	FL 80 only. Weak. Pro.Fact. doubtful.
30	+750	290	C	S	0.000,2	Avg FL 80 and TL C.
31	-220	480	C	S	0.000,2	
32	+390	360	C	S	0.000,4	Avg FL 82 and TL Y.
33	+790	280	C	S	0.000,4	Avg FL 81,82.
34	+730	590	C	S	0.000,1	
35	+430	350	C	S	0.000,3	FL 82 only. Complex.
36	+380	360	C	S	0.000,2	FL 83 only. Complex.
37	-50	450	C	S	0.000,4	Avg FL 80 and TL D.
38	+420	360	C	S	0.000,4	Avg FL 81,82.
39	+750	290	C	S	0.000,3	
40	+1,020	240	C	S	0.000,2	FL 84 only.
41	+430	350	C	S	0.000,3	
42	+360	370	C	S	0.000,6	Avg FL 83 and TL E.
43	+520	340	C	S	0.000,3	Av FL 81,82.
44	+1,130	210	B	D	0.000,4	m=3500', d=40°S. Probably too shallow.
45	+400	360	?	S	0.000,1	FL 79 only. Weak. Not necessarily continuous with 46.
46	+530	330	?	S	0.000,1	FL 78 only. See 45.
47	+430	350	C	S	0.000,3	
48	+100	420	C	S	0.000,4	Avg FL 77 and TL D.
49	+200	400	C	S	0.000,1	Very weak.
50	+480	340	C	S	0.000,3	FL 82 only. Too complex on FL 81.
51	-280	500	C	S	0.000,5	Asymmetrical.
52	+140	410	C	S	0.000,3	Avg FL 84,85.
53	+170	410	C	S	0.000,4	Avg FL 84,85.

No	Calc Elev	20% of Total Depth	Grd	Mthd	Magn. Susc. Contrast	Remarks
54	-30	450	C	S	0.000,2	
55	+420	360	C	S	0.000,2	FL 81 only. Too complex on FL 82.
56	-1,000	640	C	S	0.000,3	
57	-200	480	B	S	0.000,2	Good avg FL 78, 79.
58	-660	570	C	S	0.000,1	Very weak.
59	-330	500	C	S	0.000,2	
60	+100	420	C	S	0.000,2	
61	-370	510	C	S	0.000,1	Very weak. Too weak on FL 76.
62	-1,200	680	C	S	0.000,3	
63	+460	350	B	S	0.000,5	Avg of 4 determinations, two each on FL 71 and TL D. Ring anomaly.
64	-1,100	660	C	S	0.000,1	Good avg FL 72,73, but weak anomaly.
65	-1,820	800	C	S	0.000,2	Avg of 4 determinations, two each on FL 71 and TL E. Ring anomaly.
66	-1,320	700	?	S	0.000,1	Very weak, distorted.
67	-2,500	940	?	S	0.000,2	Avg FL 69,70. Distorted.
68	-7,600	1960	C	S	0.000,8	Large body,probably intrabasement, FL 71 only as it is usually too disturbed by superimposed anomalies.
69	-800	600	C	S	0.000,2	Avg FL 71 and TL G. Fairly complex.
70	-500	540	B	S	0.000,3	FL 72 only. Good check to 71.
71	-540	550	A	D	0.000,3	m=4500', d=60°S.
72	-120	460	B	S	0.000,5	Good avg of double anomaly on FL 74.
73	-1,670	770	?	S	0.000,2	Avg FL 72,73. Possibly too deep.
74	-350	510	C	S	0.000,1	
75	-750	590	?	S	0.000,4	Very asymmetrical. Pro.Fact. doubtful.
76	-500	540	B	S	0.000,4	Good avg FL 75, TL G.
77	-1,400	720	C	S	0.000,2	Avg FL 75,76.
78	-720	580	?	S	0.000,2	Possibly complex anomaly.
79	-850	610	?	S	0.000,6	Avg FL 78,79. Complex.
80	-1,000	640	A	D	0.000,5	m=3300', d=70°S. Fair check by S.
81	+370	370	B	S	0.000,4	Good avg FL 81,82.
82	-750	590	?	S	0.000,2	Complex anomaly.
83	+950	250	B	S	0.000,2	Good avg FL 84,85.
84	+550	330	C	S	0.000,4	Avg FL 81,82.
85	-130	470	C	S	0.000,4	Could be complex.
86	+640	310	C	S	0.000,5	Avg FL 81,82.
87	-340	510	C	S	0.000,4	Avg FL 78, 79.
88	-830	610	?	S	0.000,8	Pro. Fact. doubtful.
89	-230	490	C	S	0.000,3	Avg FL 81,82.
90	-700	580	?	S	0.000,3	Complex anomaly.
91	+640	310	C	S	0.000,2	Complex zone.

No	Calc Elev	20% of Total Depth	Grd	Mthd	Magn. Susc. Contrast	Remarks
92	+400	360	C	S	0.000,3	Avg FL 84,85.
93	-400	520	C	S	0.000,7	Avg FL 83 and TL G.
Sheet 2, Alroy Survey :						
1	-1,070	650	C	S	0.001,2	Generally complex.
2	-630	570	?	S	0.000,5	FL 89 only. Pro.Fact. doubtful.
3	-9,200	2280	C	P	-	Large intrabasement body. Relatively poor error curve, break-point difficult to locate.
4	-100	460	?	S	0.000,3	FL 91 only. Complex, weak.
5	-12,400	2920	B	P	-	Large intrabasement body. Fair error curve and break-point.
6	-1,920	820	C	S	0.000,5	Broad anomaly superimposed on 5.
7	-2,030	850	?	S	0.000,3	Broad anomaly superimposed on 5. Pro.Fact. doubtful.
8	+360	370	?	S	0.000,2	FL 97 only. Pro.Fact. not known. Weak. Could be surface feature.
9	-1,970	830	C	S	0.000,2	Broad anomaly superimposed over large intrabasement feature extending beyond map area.
10	-2,180	880	B	S	0.000,3	Avg Fl 99,100. Same remarks as 9.
11	-3,100	1060	?	S	0.000,3	FL 100 only. Pro.Fact. in doubt. Same remarks as 9.
12	-1,330	710	?	S	0.000,9	Avg FL 99,100. Step Anomaly.
13	-2,500	940	?	S	0.000,3	Distorted by surface effects.
14	-2,200	880	B	S	0.000,5	Avg FL 96,97. Broad body.
15	-2,050	850	C	S	0.000,3	Broad zone, double peaked.
16	-3,400	1120	C	S	0.000,5	Avg FL 93,94. Distorted.
17	-880	620	?	S	0.000,3	FL 89 only. Pro.Fact. in doubt.
18	-470	530	C	S	0.000,7	FL 91 only. Too weak on FL 90.
19	+540	330	B	S	0.000,8	Definitely shallower than anomalies 18,20.
20	-940	630	C	S	0.000,4	Not traceable to FL 94.
21	+700	300	C	S	0.000,2	Avg FL 87,88. Fairly weak. Could be surface effect.
22	+480	340	?	S	0.000,3	FL 90 only. Pro.Fact. in doubt. Could be surface effect.
23	0	440	C	S	0.000,3	Avg FL 93,94. Complex zone.
24	-1,800	800	C	S	0.000,6	Not traceable eastwards.
25	-230	490	C	S	0.000,3	Broad zone.
26	-500	540	C	S	0.000,2	FL 97 only. Too weak on FL 96.
27	-40	450	?	S	0.000,3	Pro.Fact. doubtful. Assumed strike east-west.
28	-10	440	?	S	0.000,2	Pro.Fact. doubtful. Assumed strike east-west.

No	Calc Elev	20% of Total Depth	Grd	Mthd	Magn. Susc. Contrast	Remarks
29	-450	530	B	S	0.000,7	Good check for 30.
30	-650	570	A	D	0.000,8	m=2200', d=40°S. Fair check by S.
31	-1,020	640	A	D	0.001,3	m=1550', d=65°S. Good check by S. Relatively short, ending in the vicinity of FL 96.
32	+200	400	A	D	0.000,7	m=5200', d=90°. Relatively short, ending in vicinity of FL 100.
33	-250	490	B	S	0.000,5	Narrow body within complex zone.
34	-730	590	B	S	0.000,6	Avg FL 93,94. Narrow body within complex zone.
35	-120	460	A	D	0.002,4	m=3900', d=30°S. Fair check by S.
36	-140	470	B	D	0.002,2	m=5560', d=35°S. Somewhat disturbed to south but still valid.
37	+80	420	C	S	0.000,3	
38	-130	470	?	S	0.000,6	Pro.Fact. doubtful.
39	+670	310	C	S	0.000,3	Narrow. Could be deeper.
40	-200	480	C	S	0.000,3	Not traceable eastwards.
41	-1,120	660	?	S	0.000,5	Pro.Fact. not known. Probably much too deep.
42	-1,260	690	?	S	0.001,1	Pro.Fact. not known. Probably much too deep.
43	-100	460	?	S	0.000,4	Pro.Fact. doubtful.
44	-1,600	760	?	S	0.000,7	Step Anomaly.
45	+250	390	?	S	0.001,1	Pro.Fact. doubtful. Could be surface effect,
46	-1,300	700	?	S	0.000,9	Step Anomaly.
47	-900	620	C	S	0.000,7	Narrow body within complex zone.
48	-450	530	?	S	0.001,2	Pro.Fact. could be in doubt. Complex.
49	-1,040	650	?	S	0.001,9	Pro.Fact. doubtful. Probably slightly too deep.
50	-220	480	C	S	0.000,7	Narrow body within wider complex zone.
51	+170	410	?	S	0.000,8	Pro.Fact. doubtful, could be shallower.