REPORT NO. 4

INTERPRETATION OF AEROMAGNETIC SURVEY

OF

BLOCK I, NORTHWEST TERRITORIES, CANADA

FOR

AEROMAGNETIC SURVEYS, LIMITED
AND ASSOCIATES

AUGUST 8, 1953

GRAVITY METER EXPLORATION COMPANY

Houston, Texas

SUMMARY

Report No. 4 covers the interpretation of the aeromagnetic survey of that portion of Block I, Northwest Territories, included within longitudes 120° W 121° W, latitudes 60° 28' N and 61° 40' N. This includes sheets 13 through 16 of the sixteen individual sheets.

The final structural map, scale 1 in = 3 mi., of the basement surface is included for the entire area of Block I. This map is contoured at an interval of 2000 ft and is entirely based on estimates of the basement (preCambrian?) depth calculated from the magnetic data. The local areas of interest indicative of local relief of the basement surface, are also included. In addition this report includes the observed magnetic maps and the second vertical derivative maps of the individual sheets, 13 through 16, scale 1 in = 1 mi. The local areas of interest are superimposed on each of these maps, and the associated residual magnetic contours are superimposed on the observed magnetic maps at an interval of five gamma.

The final basement structural map shows the basement dipping gently westward over the entire area with the exception that a steep syncline is formed in the extreme western part of the area, in Sheets 3 and 4, where the basement is at the minimal depth of 19,600 ft. The general rise of the basement east of this synclinal axis is interrupted in the extreme eastern portion of the sheet where the basement appears to increase steeply from 6000 to 2000 ft. Two additional distortions of this general configuration are the east west trend of the basin in the central northern portion of the area and the sharp, westward plunging nose in the southern portion of Sheet 14.

The residual magnetic anomalies, which could be caused by local relief of the basement surface, are generally unreliable when compared to other magnetic surveys. The lack of reliability is caused by the generally low amplitude of the observed magnetic anomalies and by the sharp and irregular distortions of the magnetic field which apparently originate from the heterogeneous composition and configuration of glacial debris. A prominent feature of the residual anomalies of this report is the group of anomalies, 94 through 97, which trend southwesterly through the southern portion of Sheet 14. South and east of this group, the residual anomalies have a dominant northwesterly trend. Furthermore, north of the group of anomalies 94 through 97, the basement surface appears to have a gentle, easterly reentrant within which almost no residual anomalies occur. It is felt that there is a strong possibility that an entirely different type of basin may be found north of the group of anomalies 94 through 97 and that the northwesterly flank of this group should be of great interest for petroleum exploration.

The basement structural map of Block I shows that the group of anomalies 94 through 97 may be projected southwest through anomalies 55 and 74. Furthermore, there is a second group of similarly oriented anomalies in Sheet 7, namely 43, 44 and 47, which terminate northward against an east west group, including 65 through 68. Further

northwest there is a third group of northwesterly oriented anomalies including 11, 32 35, 38, and 39. These three groups of similarly oriented anomalies lie within and on the flanks of the northeasterly reentrant of the synclinal area of the basement. The anomalies outside of this group are either oriented northwesterly or exhibit only a random orientation. Residual anomalies 94G, Sheet 14 and 35G, Sheet 6, are considered the most interesting residual anomalies on the basis of these considerations.

Contents

Maps

INTRODUCTION

This report, No. 4 completes the interpretation of the aeromagnetic survey of Block I Northwest Territories. The table below lists the program of reports.

Report	Transmittal Date, 1953	Sheets
1	February 26th	1 4
2	July 24th	5 8
3	July 30th	9 12
4	August 8th	13 16

Reference should be made to Report No. 1 for the general concepts of the interpretation and to Reports 1 through 3 for a discussion of the previous results.

THE OBSERVED AEROMAGNETIC MAPS, Sheets 13 through 16 (scale 1 in - 1 mi.)

The observed magnetic data, contoured at an interval of 10 gamma, are dominated by a series of positive and negative axes which are oriented north south in the southern portion of the area and northwest in the northern portion. These axes are considered to originate from intrabasement polarization contrasts. The relatively narrow distances between these axes and the relatively high amplitude of these anomalies in the northern portion of the area reflects the rise of the basement to 2000 ft.

SECOND VERTICAL DERIVATIVE AEROMAGNETIC MAPS, Sheets 13 through 16 (scale 1 in 1 mi)

These maps are shaded red and yellow with the red areas indicative of positive derivative values and the yellow negative. These two areas correspond approximately to the positive and negative curvatures of the observed magnetic field. This, in turn, signifies geologically that the red areas are underlain either by more ferromagnetic minerals than the yellow areas or that the ferromagnetic minerals are closer to the plane of observation in the red areas. The first of these is more often the case and is the reason for ascribing most observed magnetic anomalies to intrabasement origin. The north-south red areas in Sheets 14 through 16 and the northwesterly red areas which dominate Sheet 13 reflect the existence of more highly polarized rocks directly underneath within the basement. Sometimes these intrabasement bodies are relatively uplifted. This is indicated, for example, by residual anomaly 91F, Sheet 14.

Quite often the derivative calculation develops anomalies which could be caused by relief of the basement surface. The resolution of this type of anomaly depends upon its setting with respect to other anomalies, principally the intrabasement type, and by the type of template which is used for the derivative calculation. The outlines of possible basement relief, deduced from both the observed and derivative data, are superimposed on the derivative maps. The close correspondence between the residual anomalies and the derivative anomalies in the group 94 through 97 is an example of the derivative resolution of anomalies possibly indicative of basement relief or of suprabasement origin.

THE STRUCTURAL CONTOUR MAP ON THE BASEMENT SURFACE, Sheets 1 through 16 (scale 1 in - 3 mi)

This report completes the basement map. The results are presented on a composite of the sixteen individual observed magnetic maps with the basement mapped at an interval of 2000 ft, sub sea datum. The contours are based entirely on magnetic depth estimates which are shown in hundreds of feet, underlined by three, two and one underlines for good, fair and poor dependability. A fourth category is followed by the letter "S" indicating that the estimate was made with the assumption of local basement relief. In addition, local basement features possibly indicative of local basement relief have been added to show their relationship to the regional configuration.

In general the basement dips westward from -2000 ft in Sheet 13 to -19,600 ft in Sheet 4. This gentle westward dip is abruptly terminated along the eastern boundaries of Sheets 3 and 4 at a synclinal axis west of which the basement is shown to rise to a level of -9100 ft. The dip into the synclinal trough is steep. The second locale of steep dip is on the extreme eastern margin of Block I where the basement apparently dips from 2000 ft to 6000 ft very abruptly. The area between these steep dips is generally flat and between 8000 and -12,000 ft. This flat area is bounded on the north by a southerly dipping area and is interrupted in the southwest corner of Sheet 14 by a relatively sharp westward plunging nose with almost 2000 ft of relief.

The surface geology of Block I, as shown by Map 820-A (1945) of the Department of Mines and Resources of Canada, scale 1 in 60 miles, shows that Block I lies in an area covered almost entirely by Devonian and Carboniferous rocks with the exception of the extreme southern portion where Cretaceous outcrops mark the northern limit of the Mesozoic rocks which crop out in the Alberta Basin, the huge trough of sedimentary rocks between the Canadian Shield and the Canadian Rockies. The basement map computed from the magnetic data defines the synclinal axis of the basin and indicates that the basin's floor is abruptly downwarped into the syncline and is also abruptly downdropped along its eastern margin.

RESIDUAL MAGNETIC ANOMALIES (Sheets 13 through 16)

The residual magnetic anomalies are superimposed on the observed magnetic data and are contoured at an interval of five gamma. In addition the outlines of the related areas of interest or faults are shown. These outlines are the periphery of the postulated basement uplift that could cause the residual anomaly. Again the anomalies are graded G.

F and P for good, fair and poor. The outlines of the local areas of interest are also included on the derivative maps and the basement map.

Table 1: Residual Anomalies

No.*	Location	Remarks
88F	Sheet 13	This fault, downdropped to the north, marks the end of a large intrabasement anomaly which is considered to have relief in some parts. The anomaly is on the northern boundary of the survey.
89P	Sheet 13	This is a fault trace, downdropped to the northeast, indicated by weak magnetic anomalies of less than 10 gamma. This is a very poor feature.
90G & 91F	Sheets 13 & 14	These two anomalies lie along a prominent observed magnetic anomaly which is actually the cause of the excellent derivative anomaly. 91F has a basement estimated at -1100 ft whereas the basement is estimated at -5300 ft at 90G.
92P	Sheet 14	This is a fault trace, downdropped to the northeast, derived from anomalies of about 5 gamma. This is a very poor feature.
93P	Sheet 14	The anomaly is undoubtedly the best of the poor grade anomalies although its relief is only 5 gamma. Its location on the northern slope of the regional basement nose lends additional interest.
94G, 95F, 96G, 97F and 98P	Sheet 14	This group of anomalies lies along a southwest lineament. The basement depths along this trend are approximately 2000 ft higher than the surrounding area and form the basis for the conspicuous southwestward plunging nose of the basement map. These anomalies are probably the most interesting residual features of this report.
99P	Sheet 14	This fault trace, downdropped to the north, is on the north end of a prominent derivative feature which could very well be intrabasement in origin.
100P	Sheet 14	The anomaly is graded poor because of its low amplitude.

* G, F, and P, Good, Fair and Poor

No.	Location	Remarks
101F	Sheets 14 & 15	The derivative indicates that this anomaly lies on the northeasterly flank of a larger feature all of which cannot be attributed to basement relief.
102F	Sheets 14 & 15	The anomaly is difficult to resolve because of its complex relationship to intrabasement effects. It is probably the best of the fair anomalies.
103P	Sheets 14 & 15	The amplitude of this anomaly is greatest in its northern half where it is very nicely confirmed by a derivative anomaly.
104P	Sheet 15	The excellent derivative expression of this feature is considered to come from the abrupt change in slope of the observed data in this area. The resolution of this residual effect from the observed data is difficult and unreliable.
105P	Sheet 15	The anomaly is of low relief and is most reliable in its northwestern half where it has good derivative confirmation.
106F	Sheet 15	This anomaly lies obliquely to the observed magnetic contours, has a relief of more than 10 gamma, and has a somewhat fragmentary derivative representation.
107P	Sheet 15	The anomaly suggesting this fault trace has a relief of 25 gamma but its short length detracts from its possible significance.
108P	Sheet 15	The oblique relationship of this anomaly to the observed magnetic contours makes the resolution of the feature from the observed data dependable. However, the anomaly is inconsistently expressed throughout its area.
109P	Sheet 15	The anomaly has considerable amplitude, 15 gamma, but is too sharp to come from the estimated depth of the basement in that area, 6000 ft.
110P	Sheet 15	This anomaly is easily seen on the observed data and could quite probably be from near surface effects.
111P	Sheet 15	The indications of this anomaly or the observed data are weak and inconsistent.

No.	Location	Remarks
112F	Sheet 15	Two depth estimates, made on this anomaly with the assumption that local relief of the basement surface was present, gave answers of -7100 ft which fit the regional basement configuration very well. The anomaly would be upgraded if it were more consistently expressed. It is difficult to resolve certain parts because of the interference of near surface effects.
113P	Sheet 15	The main reason for including this small feature is that a basement depth of -7400 ft was made with the assumption of local basement relief.

CONCLUSION

The principal results of the aeromagnetic survey of Block I should be the basement structural map because most of the anomalies of the survey are of intrabasement origin. This, of course, is generally the case, and is a further example of utilizing the airborne magnetometer to map the regional configuration of the floor of a sedimentary basin.

The basement depths were computed entirely from the magnetic data. Experience indicates that an individual computation can be expected to be incorrect by perhaps 10% of the [illegible] depth estimate. That is, the flight level must be added to the subsea va[illegible] to obtain the total depth estimates. Sheets 1 through 4 were flown at 5500 ft and Sheets 5 through 16 were flown at 3500 ft above sea level. Therefore, the basement map is somewhat diagramatic and any exact usage of the basement depths is unjustified.

The resolution of anomalies which are possibly indicative of local relief of the basement surface, those anomalies which we call "suprabasement", was exceedingly difficult because of the low relief of the observed magnetic data and because of the very substantial near-surface effects, attributed to the heterogeneous composition and configuration of glacial debris. Furthermore, petroleum exploration in the Alberta Basin to date has shown little if any utilization of local preCambrian structure. The large oil fields of the basin, Leduc and Redwater, are stratigraphic traps and have not exhibited any dependence on local basement structure. Therefore it has not been surprising that good local basement features were hard to develop. It should be kept in mind while using the magnetic data that the indications of local basement relief are of secondary importance and that the regional basement configuration is the primary result of this interpretation.

GRAVITY METER EXPLORATION COMPANY

Nelson C. Steenland

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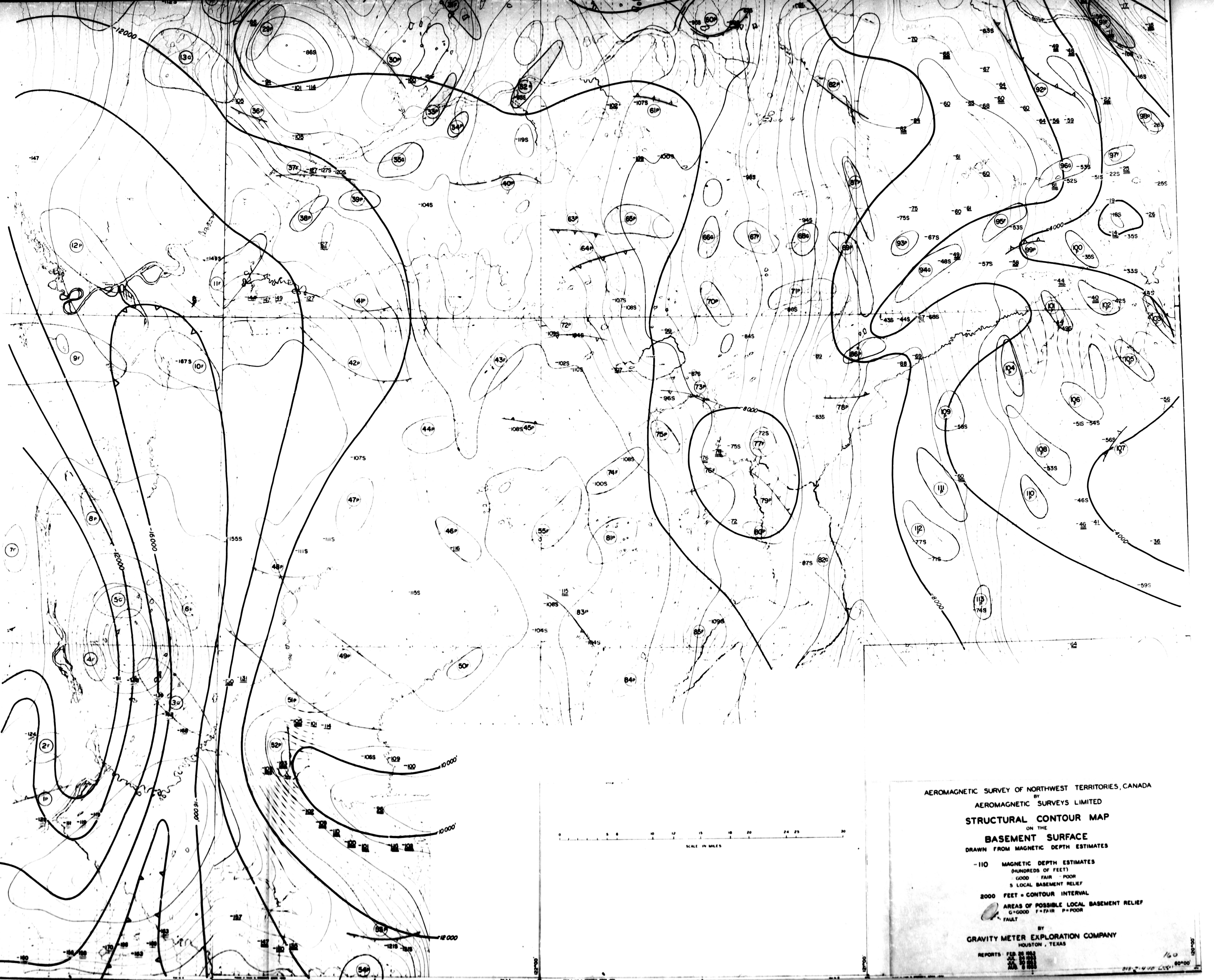
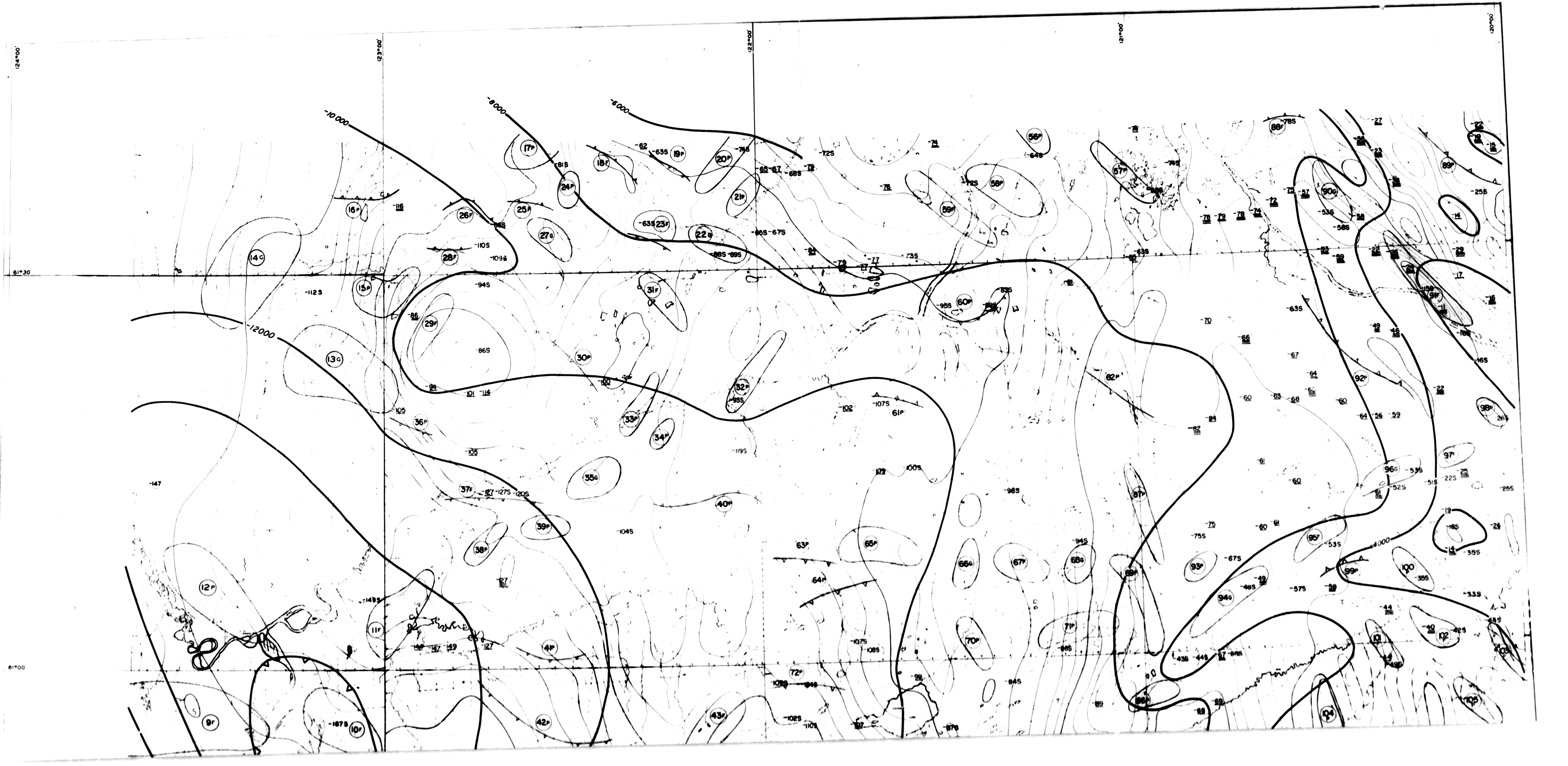
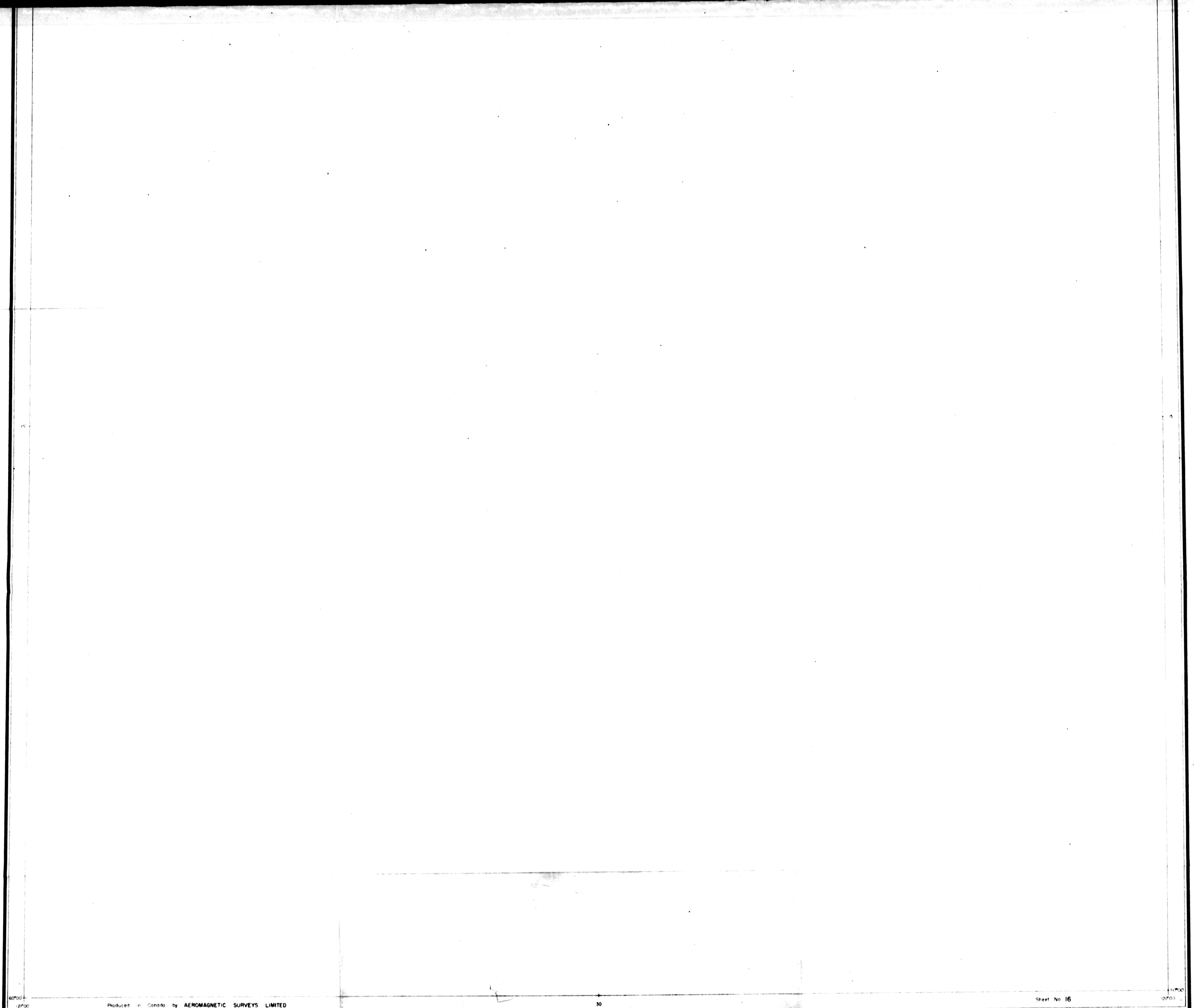

AEROMAGNETIC SURVEY OF NORTHWEST TERRITORIES, CANADA
BY
AEROMAGNETIC SURVEYS LIMITED
STRUCTURAL CONTOUR MAP
ON THE
BASEMENT SURFACE
DRAWN FROM MAGNETIC DEPTH ESTIMATES
-110 MAGNETIC DEPTH ESTIMATES
(HUNDREDS OF FEET)
GOOD FAIR POOR
S LOCAL BASEMENT RELIEF
2000 FEET = CONTOUR INTERVAL
AREAS OF POSSIBLE LOCAL BASEMENT RELIEF
G=GOOD F=FAIR P=POOR
FAULT
BY
GRAVITY METER EXPLORATION COMPANY
HOUSTON, TEXAS
REPORTS: FEB. 26 1953
SCALE IN MILES
12000
16000
10000
8000
4000
120°00'
60°00'


124°00'
123°00'
122°00'
121°00'
120°00'
61°30'
61°00'
-10,000
-8000
-6000
-12000



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Sheet No 16

MEAN FLIGHT LINE SPACING .... ⅕ MILES
ALTITUDE* .... 3500 FEET ABOVE SEA LEVEL
500 GAMMA CONTOUR ....
100 GAMMA CONTOUR ....
20 GAMMA CONTOUR ....
10 GAMMA CONTOUR ....
MAGNETIC LOW ....
FLIGHT LINES ....

SCALE

MILES — MILES

1 Inch to 1 Mile

SECOND VERTICAL DERIVATIVE MAP

CONTOUR INTERVAL 2×10^{-15} C.G.S.

CALCULATED BY

GRAVITY METER EXPLORATION COMPANY
HOUSTON, TEXAS REPORT , 1953

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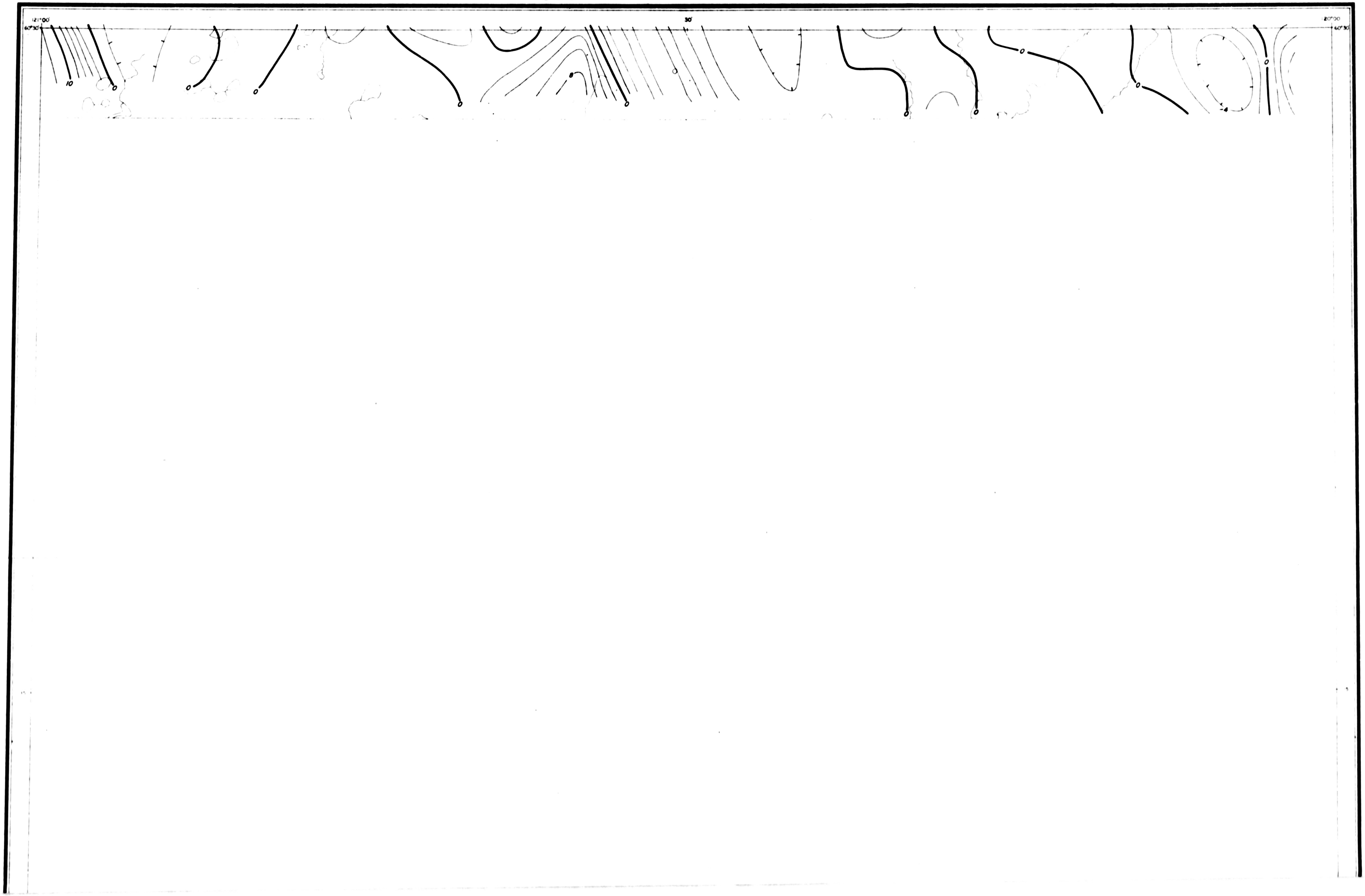
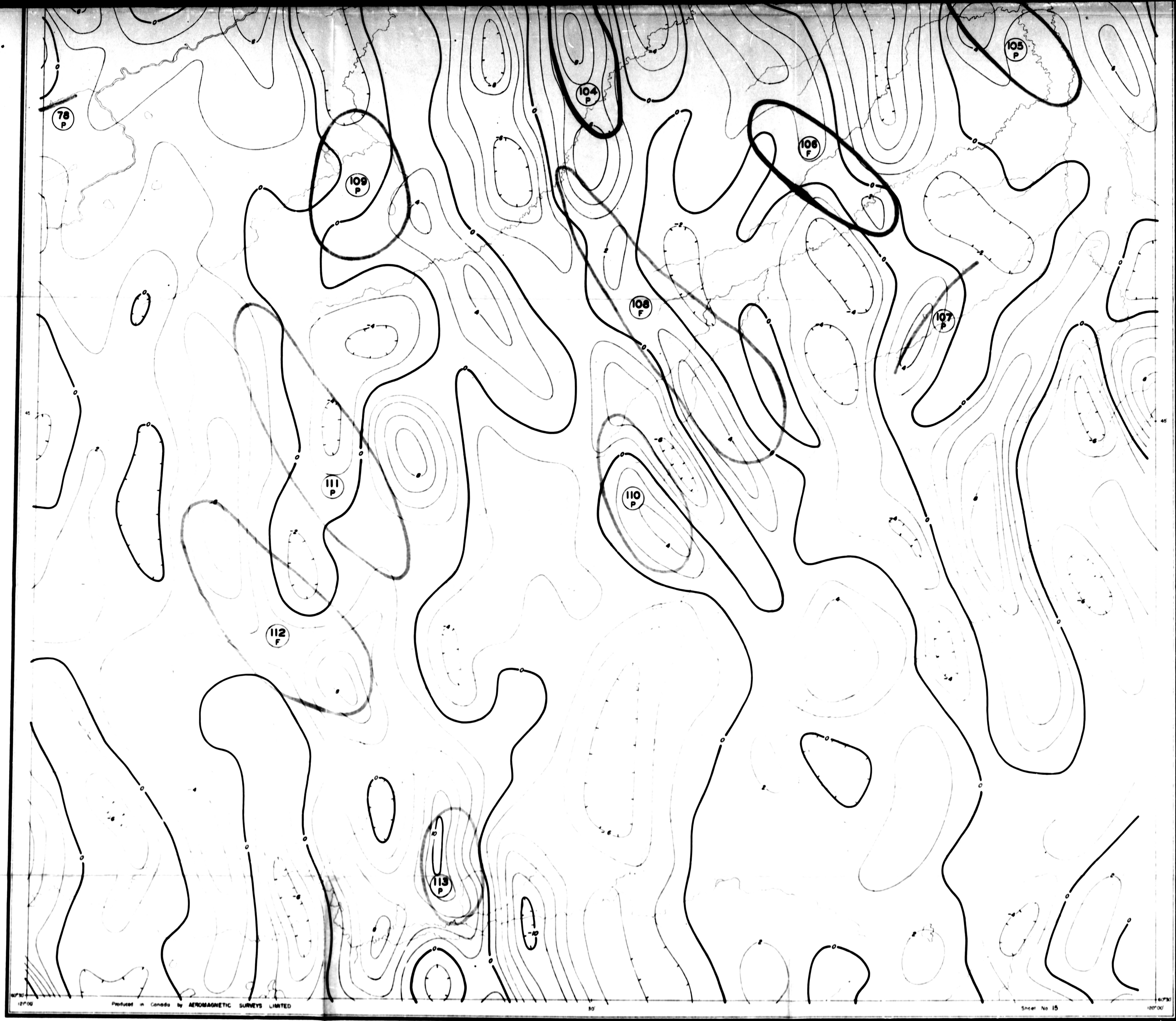
SIMPSON – LIARD AREA, N.W.T.
1952 AEROMAGNETIC SURVEY





MEAN FLIGHT LINE SPACING .... .15 MILES
ALTITUDE .... 3500 FEET ABOVE SEA LEVEL
500 GAMMA CONTOUR
100 GAMMA CONTOUR
20 GAMMA CONTOUR
10 GAMMA CONTOUR
MAGNETIC LOW
FLIGHT LINES

SCALE

1 Inch to 1 Mile

SECOND VERTICAL DERIVATIVE MAP

CONTOUR INTERVAL 2×10^{-15} C.G.S.

CALCULATED BY

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HOUSTON, TEXAS REPORT: , 1953

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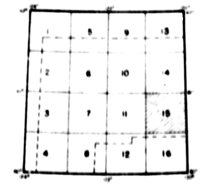

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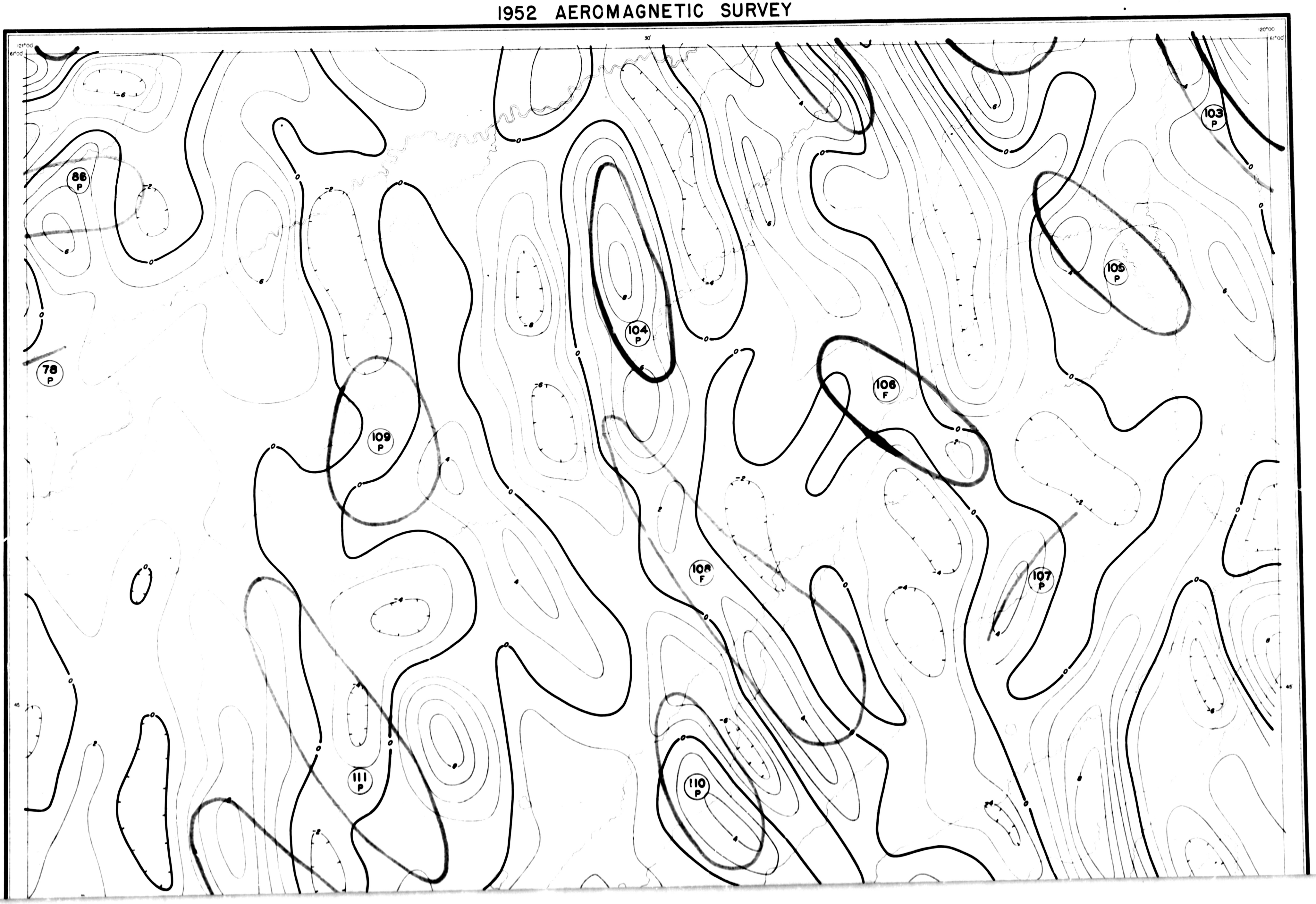

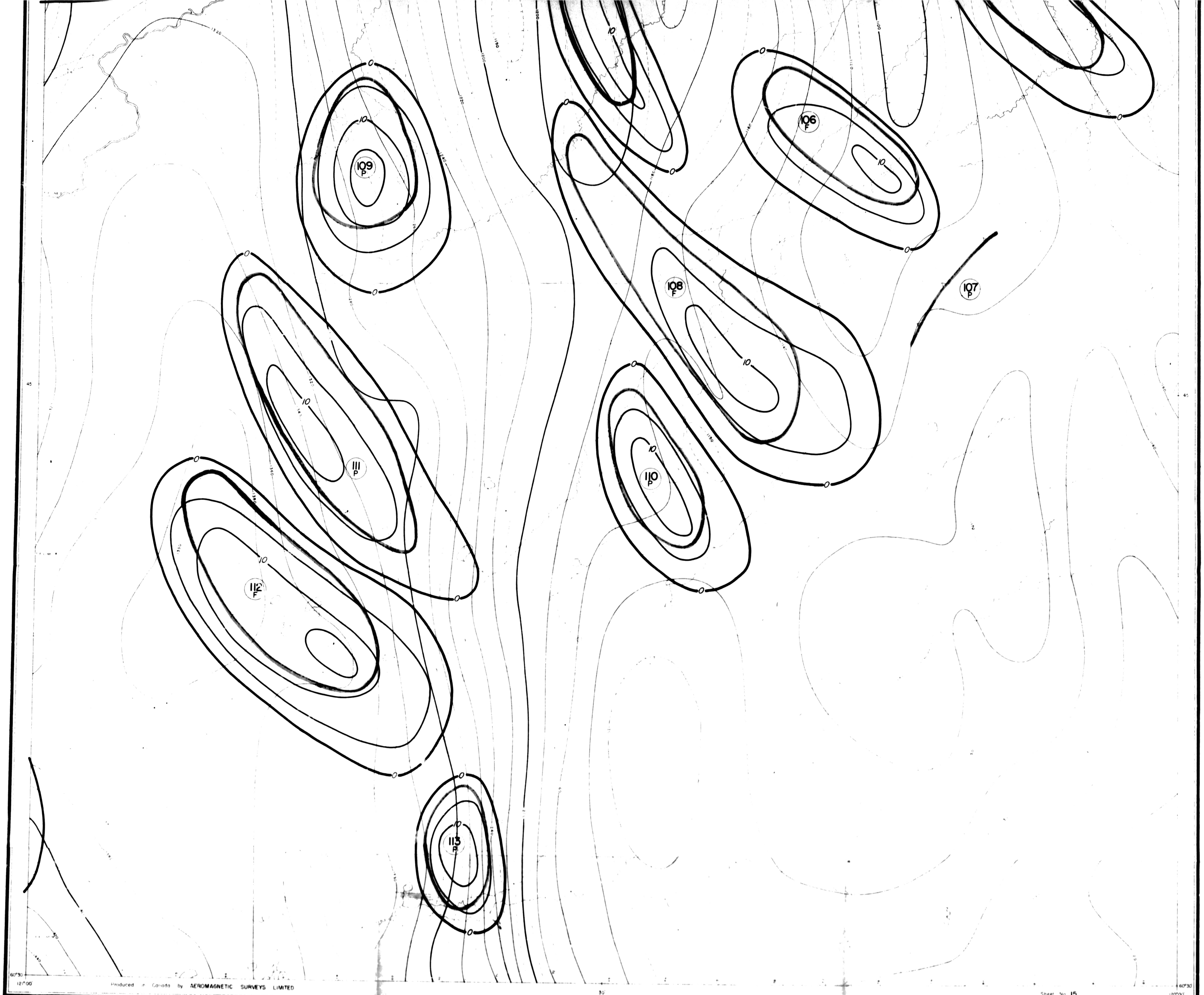

MEAN FLIGHT LINE SPACING .... MILES
ALTITUDE .... 3500 FEET ABOVE SEA LEVEL
500 GAMMA CONTOUR ....
100 GAMMA CONTOUR ....
20 GAMMA CONTOUR ....
10 GAMMA CONTOUR ....
MAGNETIC LOW ....
FLIGHT LINES ....

SCALE

MILES

1 inch to 1 Mile

MILES

RESIDUAL MAGNETIC ANOMALIES
CONTOUR INTERVAL 5 GAMMA

LOCAL AREA OF INTEREST
FAULT

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HOUSTON, TE[redacted] REPORT AUGUST 8, 1953

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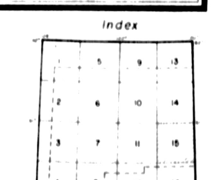
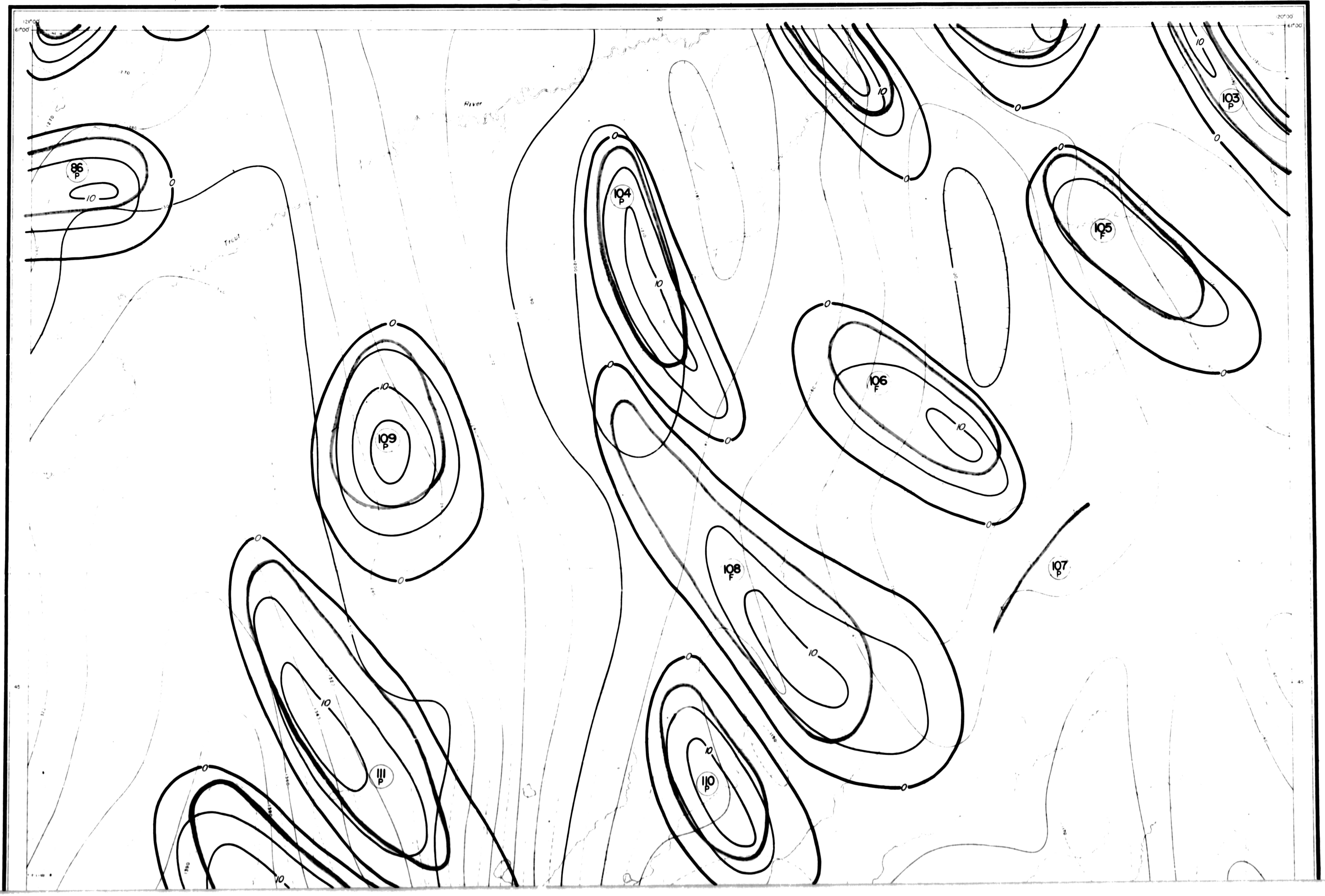
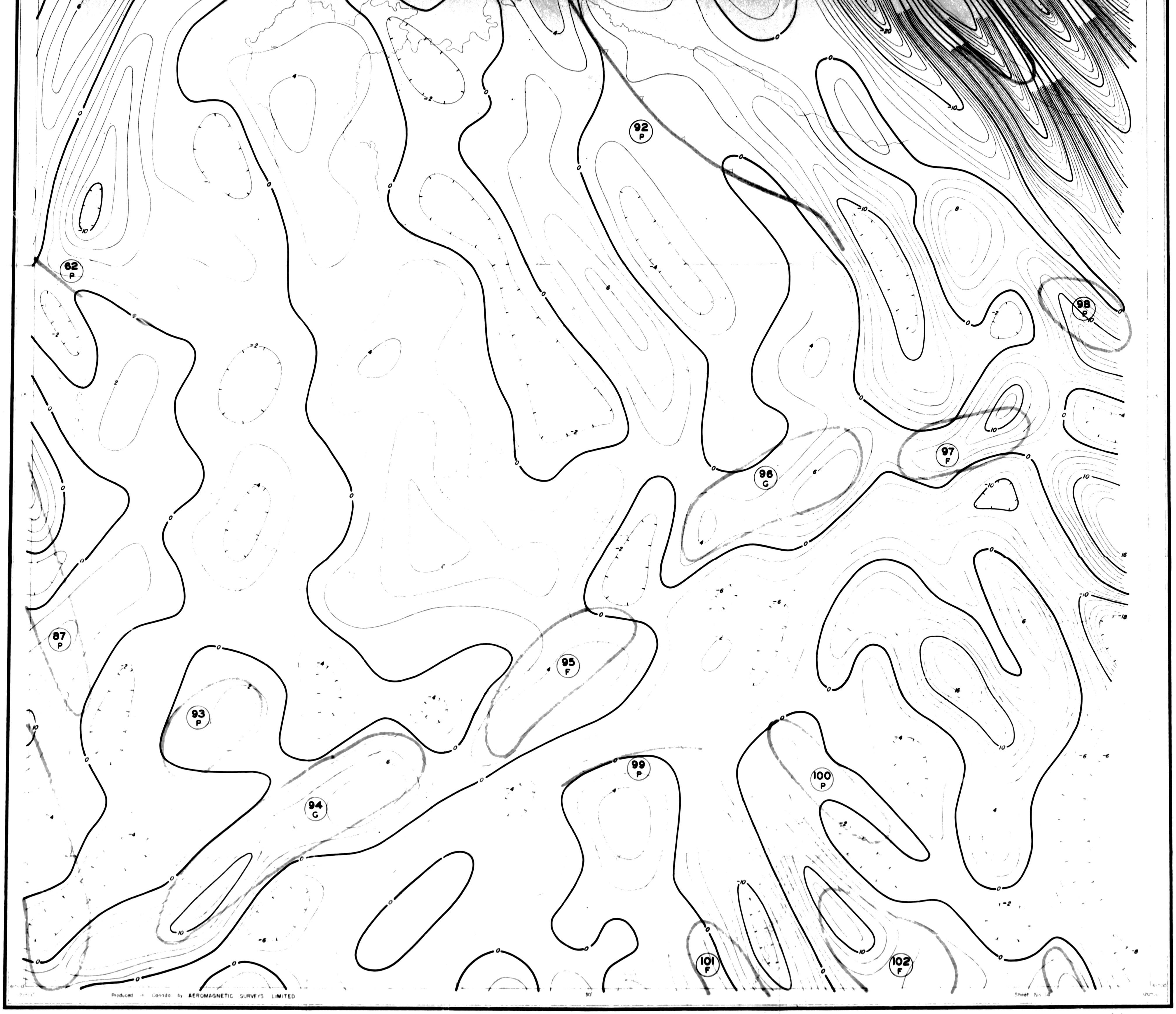


SIMPSON – LIARD AREA, N.W.T.
1952 AEROMAGNETIC SURVEY





MEAN FLIGHT LINE SPACING ... MILES
ALTITUDE ... FEET ABOVE SEA LEVEL
... GAMMA CONTOUR
... GAMMA CONTOUR
... GAMMA CONTOUR
... GAMMA CONTOUR
MAGNETIC LOW
FLIGHT LINES

SCALE
1 Inch to 1 Mile
MILES

SECOND VERTICAL DERIVATIVE MAP

CONTOUR INTERVAL 2×10^{-15} C.G.S.

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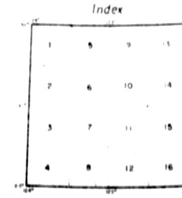

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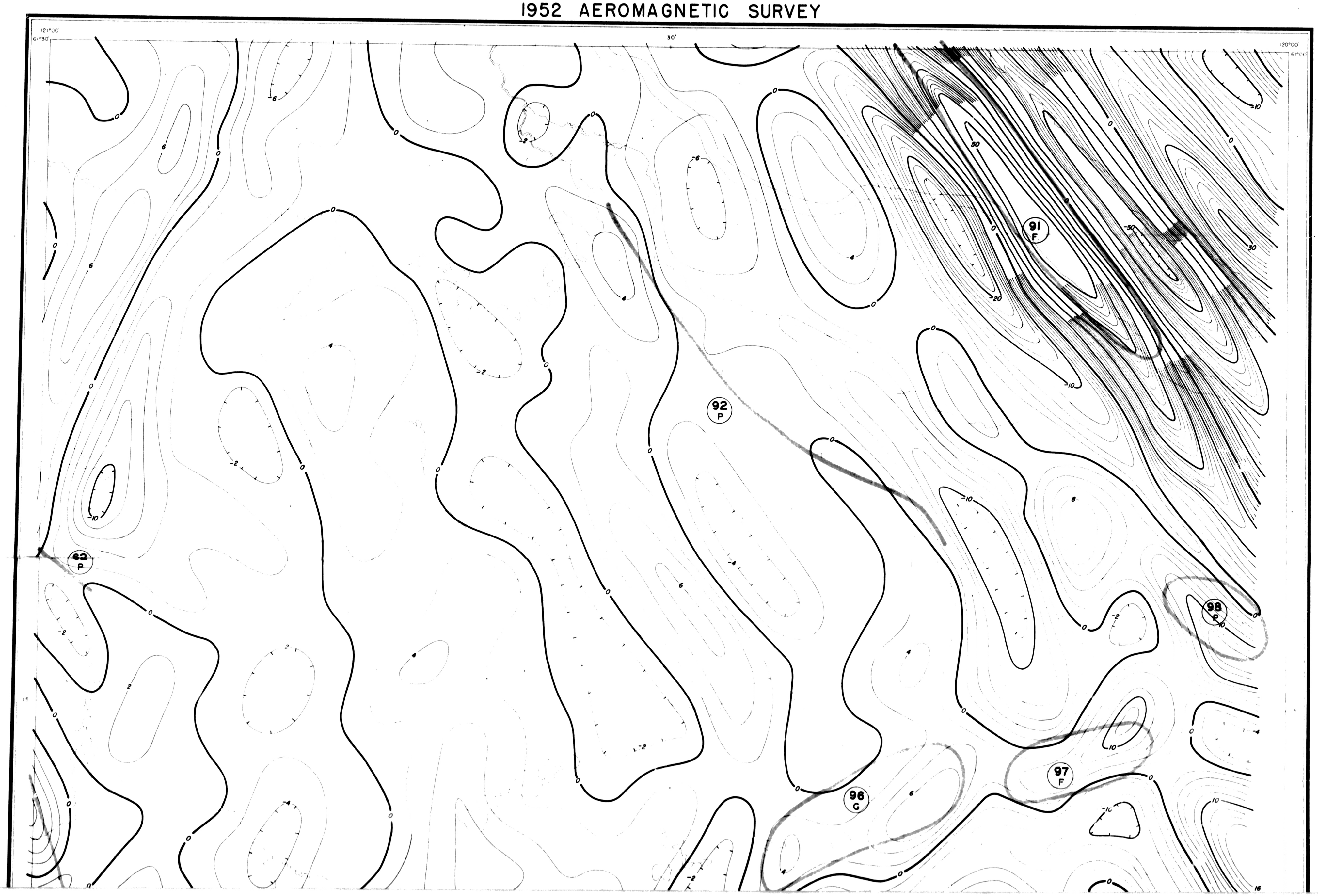

RIVER
92 P
98 P
97 F
96 G
95 F
87 P
93 P
94 G
99 P
100 P
69 F
101 F
102 F
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Sheet No 14
MEAN FLIGHT LINE SPACING
ALTITUDE 3500 FEET ABOVE SEA LEVEL
GAMMA CONTOUR
GAMMA CONTOUR
20 GAMMA CONTOUR
10 GAMMA CONTOUR
MAGNETIC LOW
FLIGHT LINES
SCALE
1 Inch to 1 Mile
RESIDUAL MAGNETIC ANOMALIES
CONTOUR INTERVAL 5 GAMMA
LOCAL AREA OF INTEREST
FAULT
INTERPRETED BY
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HOUSTON, TEXAS
REPORT AUGUST 8, 1953
Index
1 5 9 13
2 6 10 14
3 7 11 15
4 8 12 16

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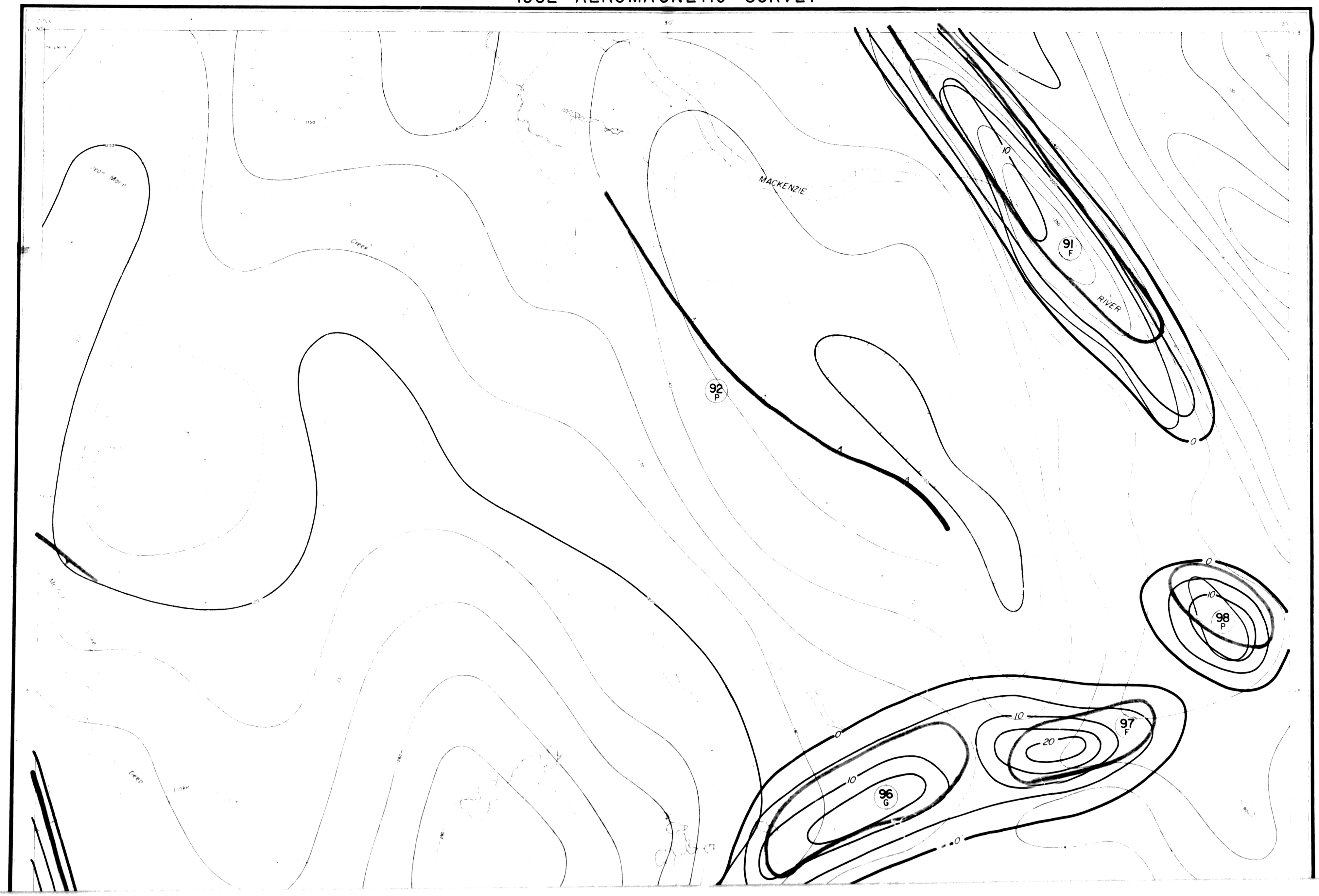

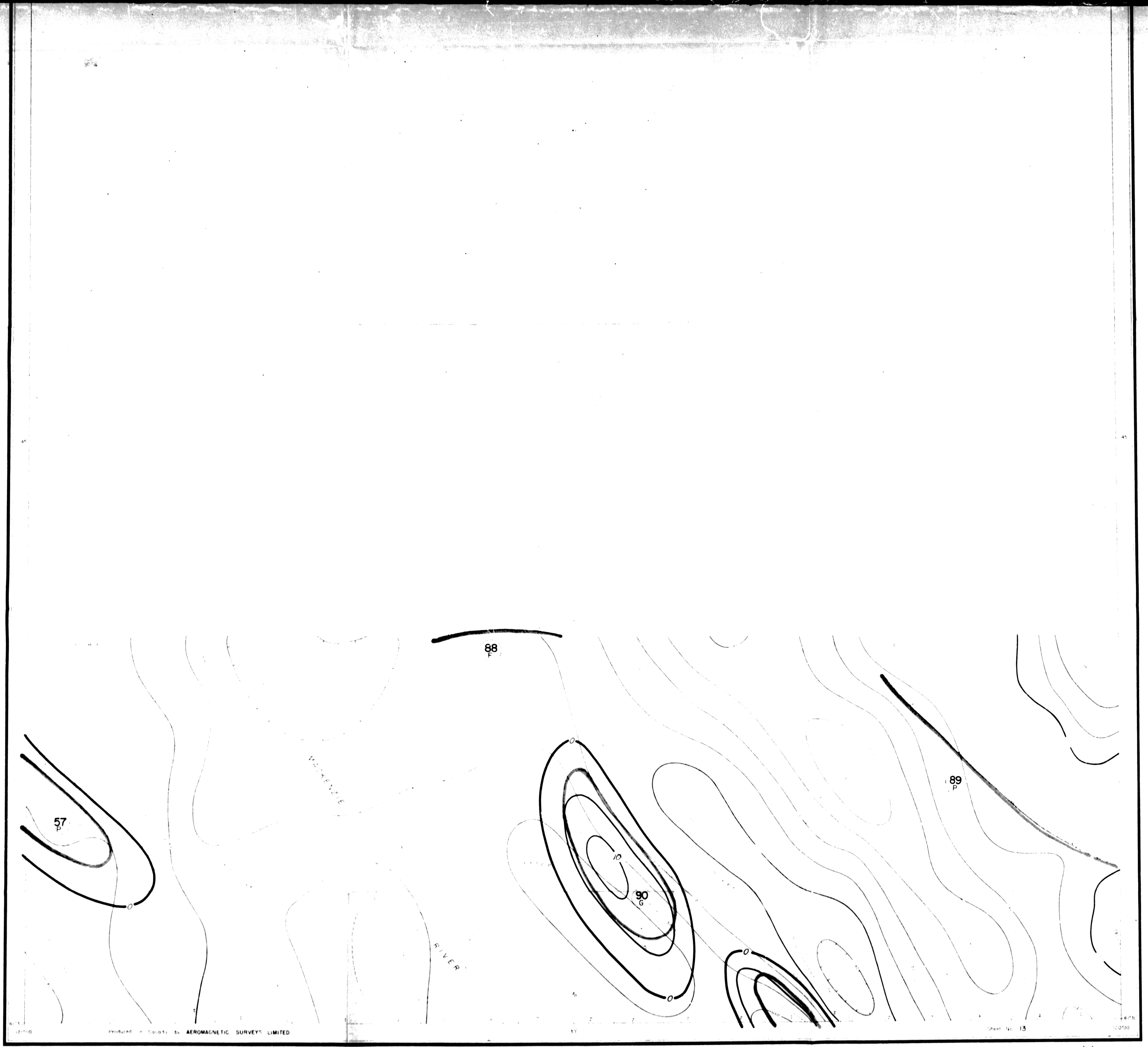

ALTITUDE 1500 FEET ABOVE SEA LEVEL
GAMMA CONTOUR
GAMMA CONTOUR
GAMMA CONTOUR
GAMMA CONTOUR
MAGNETIC LOW
FLIGHT LINES

SCALE
MILES
1 Inch to 1 Mile
MILES

RESIDUAL MAGNETIC ANOMALIES
CONTOUR INTERVAL 5 GAMMA

LOCAL AREA OF INTEREST
FAULT

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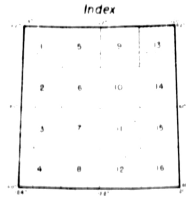

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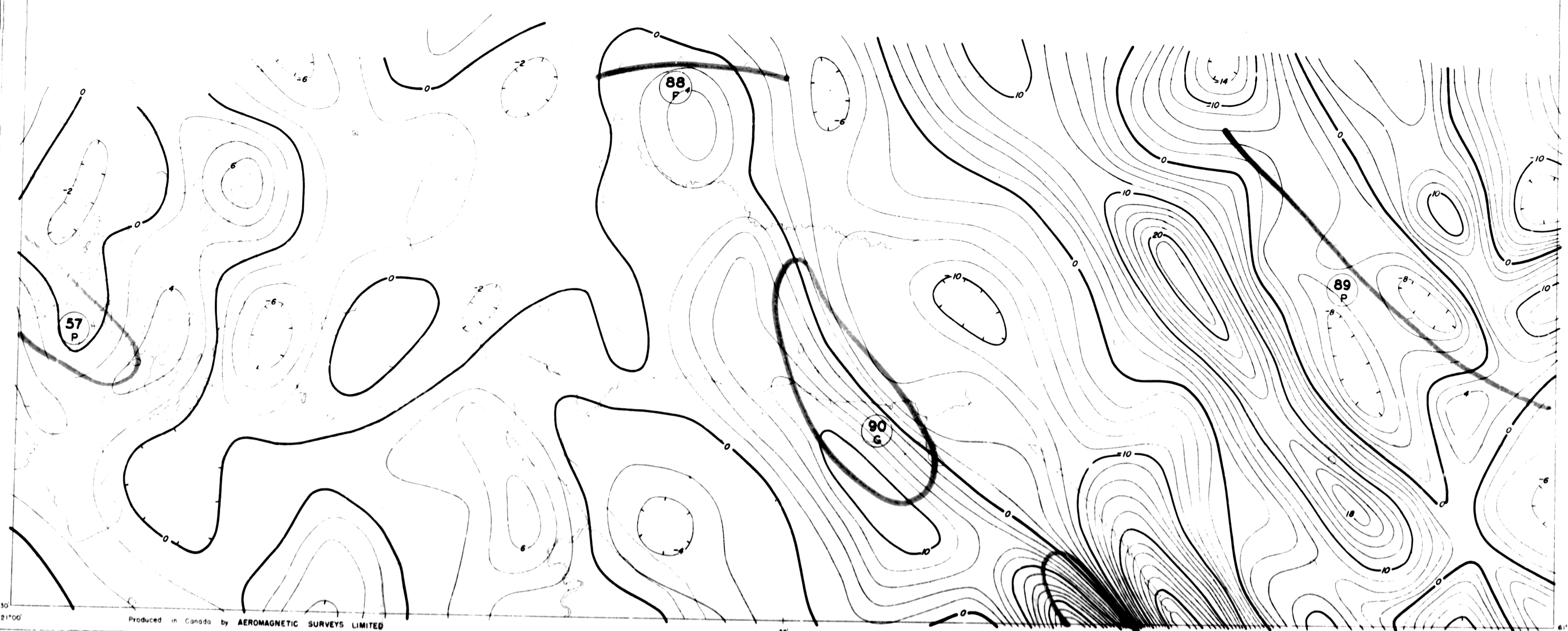

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Sheet No 13

MEAN FLIGHT LINE SPACING MILES

ALTITUDE 3500 FEET ABOVE SEA LEVEL

500 GAMMA CONTOUR

100 GAMMA CONTOUR

20 GAMMA CONTOUR

10 GAMMA CONTOUR

MAGNETIC LOW

FLIGHT LINES

SCALE

1 Inch to 1 Mile

MILES

SECOND VERTICAL DERIVATIVE MAP

CONTOUR INTERVAL 2×10^{-15} C.G.S.

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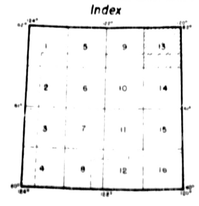

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