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INTERPRETATION OF AEROMAGNETIC SURVEY

OF

BLOCK II, NORTHWEST TERRITORIES, CANADA

FOR

AEROMAGNETIC SURVEYS, LIMITED
AND ASSOCIATES

APRIL 13, 1953

SUMMARY

This report covers the interpretation of the aeromagnetic survey of Block II, Northwest Territories, included within longitudes 120° 40' W.-120° 00' W. and latitudes 60° 20'N.-61° 10'N. The area is mapped at scale 1" = 1 mile, and the observed data are presented on four maps; Northwest, Northeast, Southwest, and Southeast.

A structural map of the regional configuration of the basement surface, contoured at an interval of 1000 foot(subsea datum) at a scale of 1" = 3 miles, has been prepared entirely from magnetic depth estimates made on intrabasement anomalies. Residual anomalies suggesting local relief of the basement surface are superimposed on the observed data. Outlines of the postulated basement disturbances are shown within each anomaly and are also included on the Basement Structural Contour Map.

The basement map indicates that the basement surface is conspicuously flat over the major portion of the survey at a general level of -2000 foot. This flatness is disturbed primarily by a relatively rapid thickening of the sedimentary section in the southwestern corner of the survey where the basement depth deepens to -6000 foot. A secondary disturbance to the flattening is a synclinal axis trending northward near the eastern edge of the survey along which the basement deepens to -4000 feet.

The area is indicated by the magnetic data to have an unusually large amount of local basement disturbances. Eighty-nine local residual anomalies are resolved. Fifteen of these are graded good, twenty-five fair, and forty-nine poor.

A Second Vertical Derivative Map, scale 1" = 1 mile was also prepared to assist in the computation of magnetic depth estimates and to aid in the resolution of the residual anomalies. This map is colored red and yellow. A more or less accurate generalization is the fact that the basement rocks under the red areas will be more highly polarized or contain more ferromagnetic minerals than the adjacent yellow area. The derivative map shows in a very striking fashion that these basement petrographic units are aligned northwesterly. This alignment gives rise to the so called northwesterly basement "grain".

Note that the outlines of the eighty-nine local basement disturbances are super imposed on the derivative map.

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MAPS

Observed Aeromagnetic Map, with local anomalies superimposed Sheets NW, NE, SW, SE, Scale 1" = 1 mi.; observed data contoured at an interval of 10 gammas; residual anomalies contoured at an interval of 5 gammas.

Second Vertical Derivative Map, with outlines of local areas of interest superimposed, Sheets NW, NE, SW, SE, scale 1" = 1 mi.; contour interval 2 x 10 -15 cgs.

Basement Structural Contour Map, with structural basement contours (interval 1000 ft.) datum, sea level), individual magnetic depth estimates, and local areas of interest superimposed on a composite of the four observed magnetic maps; scale 1" = 5 mi.

INTRODUCTION:

The interpretation of the aeromagnetic data attempts to resolve the observed magnetic anomalies into two categories intrabasement and suprabasement anomalies. The intrabasement anomalies are those which, because of their large areal size and large amplitude, must originate from large magnetization contrasts within the basement (i.e. igneous or metamorphic) rocks. These large magnetization contrasts are assumed to originate at the basement surface and to extend infinitely downward with vertical sides. With these assumptions, estimates of the depths to the tops of these anomalously magnetized bodies may be made or, conversely, the thickness of the sedimentary section may be estimated.

After these large features are resolved and are employed for the determination of the sedimentary thickness, residual anomalies remain which may be placed in other categories. The category of principal interest is the suprabasement type, anomalies which are of such shape and amplitude that they can be assumed to rise from vertically thin sheets of magnetized rock, for example, from relief of the basement surface. Another group of anomalies include disturbances from the ground surface. These produce sharp and erratic anomalies which are easily separable from those related to basement rocks.

The analysis is based on the study of the observed data, both the observed maps and the flight profiles, together with a second vertical derivative map. The second vertical derivative approximates the curvature of the observed magnetic field, and areas shaded red on the derivative map are areas of positive curvature, those shaded yellow, of negative curvature. All observed anomalies have curvature or derivative anomalies, and, in general, the large derivative anomalies, large in area and in amplitude, are the derivative anomalies of the large observed, or intrabasement, anomalies. Also, in a general way, the small and sharp derivative features are anomalies which are not intrabasement in origin and which, therefore, may be indicative of local basement relief, surface disturbances, and other sundry causes. Therefore, the derivative map assists in the resolution of the intrabasement and suprabasement features although it is at the same time affected by any other anomalies that may be present.

THE OBSERVED AEROMAGNETIC MAPS (Sheets NW, NE, SW, and SE):

The observed magnetic data of the four sheets are not dominated by any particular set of features but are, on the otherhand, an almost uninterrupted series of anomalies. The presence of so many anomalies is attributed to the relatively small basement depth and to the great magnetic heterogeniety of the basement.

The eighty-nine residual magnetic features are superimposed on the observed magnetic maps. These will be discussed in the last section.

THE SECOND VERTICAL DERIVATIVE AEROMAGNETIC MAP(Sheets NW,NE, SW and SE):

These maps, colored red and yellow, are prepared by a grid calculation for the second vertical derivative. The derivative approximates the curvature of an anomaly so that derivative maxima coincide, for the most part, with observed maxima; likewise, the derivative minima coincide with observed minima. Also, the zero derivative occurs approximately over the edge of the magnetic distrubance. Therefore, the red areas are, in a general way, superimposed over basement rock units that contain more ferromagnetic minerals than the adjacent rocks. These rock units are the main source of the magnetic anomalies, and the derivative maps delineate these disturbances much more clearly than the observed maps.

The northwesterly orientation of the greater part of the intrabasement rock units is very conspicuous on the derivative map. This banding creates the so called "grain" of

the basement. This grain is not structural in origin but must be derived from petrographic variations of the basement rock. However, the orientation of most of these features may be the result of regional adjustments of the intrabasement rock units.

The outlines of the local basement disturbances have been reproduced on the derivative maps. Sometimes intrabasement units have corresponding structural relief. For example, residual anomaly 38-P on Sheet NE. In other cases the residual feature transects the intrabasement features as, for example, 54-P on Sheet SW.

It should be emphasized that the spacing of the grid used in the calculation of the derivatives was selected to emphasize the intrabasement anomalies rather than the suprabasement or structural type. It was considered more important to delineate the intrabasement features for the purpose of developing an accurate basement structural contour map. Therefore, the basement map is the most important result of this analysis.

BASEMENT STRUCTURAL CONTOUR MAP:

The four sheets of the observed aeromagnetic data were joined together to form the base map for the basement map. The composite map is at scale 1" = 3 miles.

The individual magnetic depth estimates are shown on this map, graded good, fair, and poor with three, two and one underlines respectively. A fourth category is that group with the suffix "S" which means that the estimates were made on residual anomalies, that is on a supra- rather than a intrabasement anomaly.

The estimates were computed without regard to any other geophysical or geological data, and they have been contoured without consideration of any other data. The contours show that the major position of the survey is at a general level of -2000 feet. The basement deepens quite rapidly from this flat area in the southwestern corner of the survey to a level of -6000 feet. In addition, a synclinal axis apparently runs northward through the eastern portion of the survey where the basement deepens to -4000 feet.

The area in the southwestern corner of the survey, which is a shelf-zone between the flat area to the northeast and the basement to the southwest, is the most interesting regional feature developed.

THE RESIDUAL MAGNETIC ANOMALIES (Sheets NW, NE, SW, and SE):

The residual magnetic anomalies are superimposed on the observed magnetic data and are contoured at an interval of 5 gammas. In addition to the contours, the periphery of the corresponding area of interest is shown. In some cases this periphery is simply a fault trace. Again, the anomalies are graded, G, F, and P, for good, fair and poor.

The analysis attempts to place every magnetic anomaly that has been resolved into its proper category. If an anomaly is considered to be intrabasement, it serves as a basis for estimating basement depths. Other anomalies must be put into the suprabasement category, indicating basement structure, and into miscellaneous categories, such as near-surface disturbances. Of course the suprabasement type of anomaly can be caused by sheets of magnetic material within the basement as well as on the surface of the basement. Therefore, the suprabasement, or the residual anomaly, does not necessarily mean that basement structure is present. Further effort must be made through geophysical and geological studies to choose the residual anomalies that are most likely to originate from basement structure and to have superimposed sedimentary structure.

The grading of the anomalies is a step in this selective process. The anomalies can be graded on the basis of their magnetic dependability but those that are high graded are believed to have some geological merit as well as good magnetic dependability. For example, the good anomalies are chosen with due consideration to their location on the Basement Structural Contour Map/

Table I, below, gives some of the pertinent facts about each anomaly anticipating that these facts may be useful in the future employment of the anomalies.

TABLE I

Residual Anomalies

No.*	Location	Amplitude	Orientation	Derivative Correspondence	Basement Depth(Ft.)**
1-P	NW	5	N-S	Fair	-2000
2-P	NW	15	N-S	None	-2000
3-P	NW	25	NE	None	-2000
4-P	NW	10	NW	Poor	-2000
5-F	NW	30	NW	Fair	-2000
6-F	NW	10	None	Good	-2200
7-P	NW	15	N-S	None	-2500
8-P	NW	10	WNW	None	-2000
9-F	NW	15	N-S	Fair	-2000
10-F	NW	15	NW	Poor	-2000
11-P	NW	10	N-S	Fair	-2400
12-P	NW	10	None	None	-2500
13-F	NW	5	N-S	Good	-2400
14-G	NW	15	N-S	None	-2000
15-P	NW	10	NW	Poor	-2200
16-P	NW	10	N-S	Poor	-2700
17-P	NW	5	NE	Fair	-2000
18-G	NW	10	NNE	Fair	-2600
19-G	NW	25	NNE	Fair	-2600
20-P	NW	10	N-S	None	-2500
21-G	NW	10	NW	Good	-2000
22-F	NW	10	NW	Poor	-2600
23-P	NW	10	NE	None	-1900
24-P	NW	10	NW	Poor	-2100
25-P	NW	5	None	Good	-2100
26-P	NW	20	N-S	Poor	-1800
27-P	NW	15	NNE	None	-2200
28-P	NW	5	NW	None	-2400
29-G	NE	10	NW	Fair	-2000
30-F	NE	15	NW	Good	-2400
31-G	NE	15	NW	Good	-2500
32-P	NE	10	NW	Good	-2400
33-P	NE	10	NW	None	-4000
34-G	NE	25	N-S	None	-2600
35-P	NE	5	NW	None	-2000
36-P	NE	5	NW	Fair	-2000
37-P	NE	5	NW	Poor	-2300
38-F	NE	20	NW	Good	-2500
39-G	NE	20	NE	Good	-2500
40-G	NE	35	NW	Good	-2200
41-F	NE	5	NE	Good	-2800
42-P	NE	5	NE	None	-2300
43-P	NE	5	NE	Good	-2800
44-P	NE	5	NW	Good	-2900

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

** Basement Structural Contour Map.

No.*	Location	Amplitude	Orientation	Derivative Correspondence	Basement Depth (Ft)**
45-P	NE	5	NW	Fair	-2600
46-P	NE	10	NW	None	-2400
47-F	NW	10	NE	None	-2000
48-F	SW	5	NW	Good	-2100
49-P	SW	10	NW	Poor	-2500
50-P	SW	5	NW	Good	-2500
51-P	SW	10	NW	Good	-2000
52-G	SW	10	N-S	Good	-2200
53-P	SW	5	E-W	None	-2000
54-P	SW	5	NE	None	-2000
55-F	SW	20	NW	Good	-2500
56-F	SW	5	NW	None	-6000
57-G	SW	10	NW	Good	-5900
58-F	SW	25	NW	Good	-3000
59-F	SW	5	NW	Good	-2400
60-G	SW	20	NW	Good	-3500
61-P	SW	10	NE	Good	-4700
62-P	SW	5	NW	None	-4700
63-F	SW	5	NW	Good	-2200
64-F	SW	10	NNE	Good	-2600
65-P	SW	5	NW	Good	-3500
66-P	SW	5	NNW	Fair	-3000
67-G	SW	10	N-S	Poor	-2400
68-G	SE	10	NE	Good	-2000
69-P	SE	17	NW	Good	-2000
70-P	SE	10	NW	Good	-2600
71-P	SE	3	NW	None	-2100
72-F	SE	15	NW	Good	-1100
73-P	SE	15	NNW	Good	-3000
74-F	SE	20	NE	Good	-3500
75-P	SE	10	NNW	Poor	-2400
76-P	SE	12	NE	Good	-3500
77-P	SE	5	NW	Good	-3000
78-P	SE	20	NW	Good	-2500
79-P	SE	15	NW	Poor	-2500
80-P	SE	10	NW	Good	-2700
81-F	SE	5	NE	None	-1600
82-P	SE	5	N-S	None	-2000
83-F	SE	20	NW	Good	-3000
84-F	SE	35	NNW	Fair	-2600
85-P	SE	5	NNW	Fair	-3200
86-G	SE	15	N-S	Fair	-3200
87-F	SE	20	N-S	Fair	-2200
88-P	SE	14	NNE	Fair	-3000
89-P	SE	10	NNW	Good	-3000

Total 15 good
25 Fair
49 Poor

* G=Good, F = Fair, P = Poor.
** Basement Structural Contour Map

GRAVITY METER EXPLORATION COMPANY

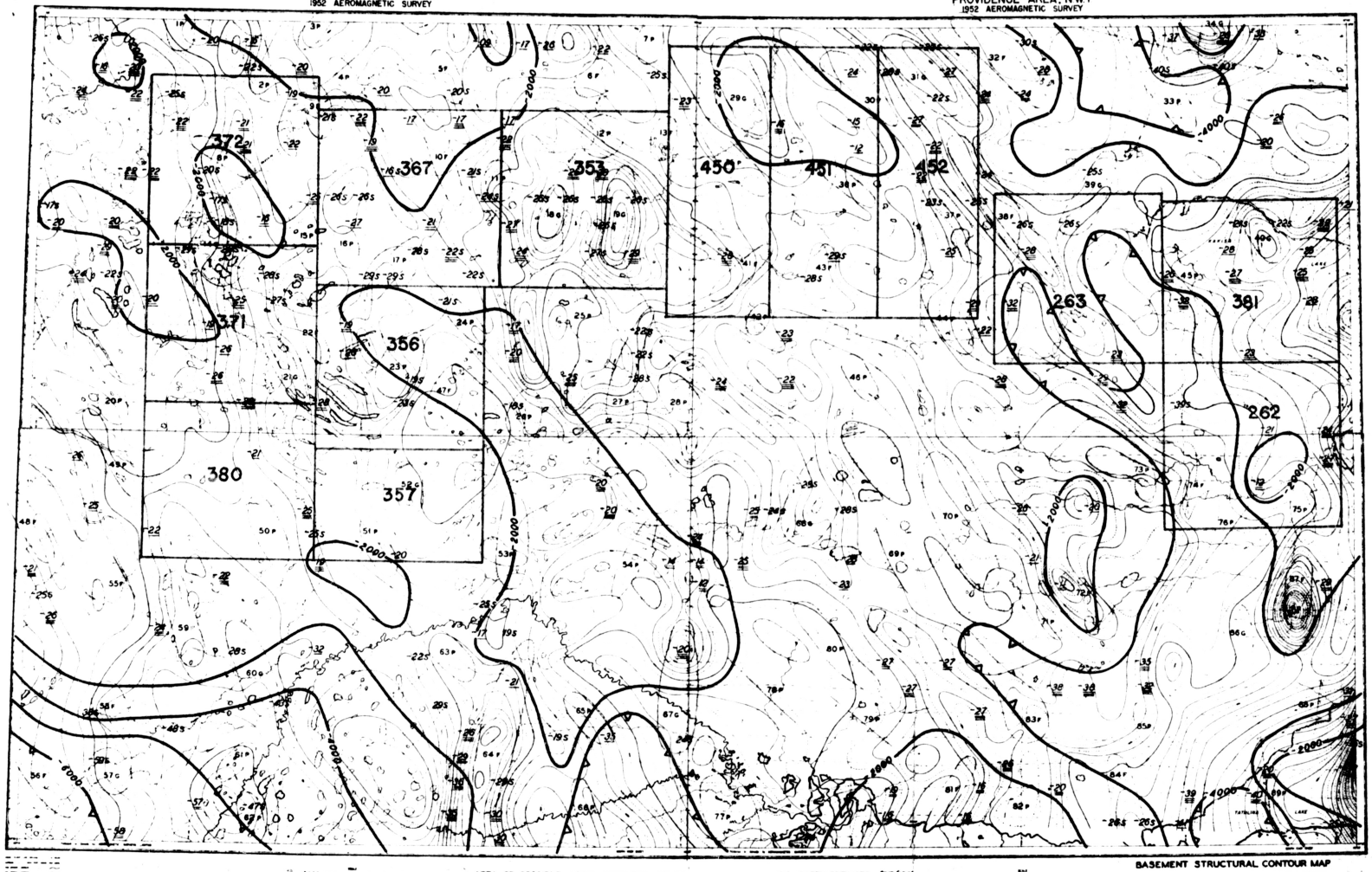
BY: Nelson C. Steenland (signed)
Nelson C. Steenland

NCS:mm
Encs.

PROVIDENCE AREA, N.W.T
1952 AEROMAGNETIC SURVEY

Plate II

PROVIDENCE AREA, N.W.T
1952 AEROMAGNETIC SURVEY



1 IN = 3 MI

AREA OF POSSIBLE LOCAL BASEMENT RELIEF
G=GOOD F=FAIR P=POOR

FAULT

-24 DEPTH ESTIMATE (FT/100)
≡ GOOD = FAIR — POOR

5 LOCAL BASEMENT RELIEF

BASEMENT STRUCTURAL CONTOUR MAP
INTERVAL 1000 FT. DATUM SEA LEVEL
DERIVED FROM MAGNETIC DEPTH ESTIMATES
BY
GRAVITY METER EXPLORATION COMPANY
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