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Date

FINAL REPORT

DIGITAL HIGH SENSITIVITY AEROMAGNETIC SURVEY

NORTHWEST TERRITORIES

SINCLAIR CANADA OIL COMPANY

SAME AS 41-7-5-4

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GEOTERREX LTD.

INTRODUCTION AND SURVEY OPERATIONS

A digital high-sensitivity aeromagnetic survey was flown over a region between Great Bear Lake and the Franklin Mountains in the Northwest Territories between July 20 and August 1, 1967. The program consisted of east-west lines one mile apart and north-south tie lines three miles apart. Originally this covered an area where ground elevations ranged from 800 to 1800 ft., and a flight altitude of 2500 feet was chosen. This area was expanded after the survey had begun, and extended just into the mountains at the south-west corner. This corner could not be flown at the set altitude and lines were cut a little short. The total mileage was 6349 line miles.

The base of operations was at Norman Wells, from 50 to 150 miles away from the survey area. Since this is close to the auroral zone, where time variations of the earth's magnetic field are often erratically disturbed, two ground monitor magnetometers were established at Norman Wells, and at Fort Franklin, which is on the east edge of survey area. The first allowed the crew to judge whether diurnal conditions were acceptable for flying, and the second was used to control the results obtained. As an additional check, a base line on the west side of the area was flown at the start and end of each survey flight. Diurnal was surprisingly stable during the period of the survey, but a total of 545 line miles were re-flown because of erratic disturbances. The diurnal variations will be the subject of a supplement to the present report.

A Douglas DC-3 owned and operated by Survair Ltd. was used as the survey aircraft. A C.S.F. caesium-vapour magnetometer was installed, the detector towed in a bird on some 250 feet of cable to remove it from the magnetic field of the aircraft. A digital frequency meter measured the total intensity of the earth's magnetic field in units of 0.01 gammas at intervals of 1 second, controlled by crystal clock. Measurements were recorded both on magnetic tape and on an analogue record for monitoring purposes. The ground magnetometers have similar characteristics.

Flight path was recorded by a 35mm continuous strip camera, and flight altitude by a Rosemount recording barometer. Fiducial marks were controlled by the crystal clock, and set on the film and analogue records at 50 second intervals.

SURVEY COMPILATION

Data processing included the following steps:

1. Flight path recovery on mosaics, and transferring points to base maps.
2. Locating times of intersections of north-south and east-west lines by crossing 35mm films.
3. Reading X-Y coordinates of intersections on maps using a Universal Transverse Mercator grid.

4. Preparing IBM cards showing times and X-Y coordinates of every intersection.
5. Checking and correcting flight path by computing aircraft ground speed between every intersection.
6. Converting air and ground magnetometer readings from magnetic tape to punched cards and correcting any recording errors.
7. Smoothing data and subtracting ground from airborne measurements.
8. Printing Calcomp profiles.
9. Computing differences of magnetic measurements from both lines at each intersection.
10. Adjustment of differences to level data together.
11. Computing final magnetic values, including regional correction, and X-Y coordinates at 5 second intervals.
12. Transcribing, contouring and drafting final magnetic maps.

INTERPRETATION BACKGROUND

The interpretation has been based on close study of the Calcomp profiles and the contour maps completed in steps 8 and 12 of the compilation. Calcomp profiles were printed using two vertical scales, 50 and 5 gammas per inch, so that large and small anomalies could be examined conveniently. Extra Calcomps at 5 gammas per inch were printed in some places, removing a strong regional slope that made analysis difficult.

A brief discussion of the methods used, and the concepts involved, is given below.

The routine of interpretation follows three stages. First breaking down the complex pattern of features into separate magnetic anomalies. Second analysing anomalies to determine their causes, particularly depths to their sources. Third, interpretation and synthesis of results in geological terms.

The first stage is based on the usual assumption that a particular anomaly arises from contrasts in magnetization between a particular body of rock and its neighbours. This assumption has been well justified by correlation of geological mapping with magnetic surveys over exposed Precambrian rocks. Anomalies have been separated by drawing tangents through inflection points on the profiles, one on either side of each peak or shoulder. This is a straightforward process, except in zones where anomalies from different levels are superposed. For instance, it may be very difficult to recognize a broad anomaly from basement rocks when a series of sharp features from shallow volcanics override it.

Inflection point locations were transferred from the profiles to the map, and traced from line to line. Individual anomalies were then outlined on the map, the outline generally following the inflection points. These outlines have a physical basis. For steeply dipping edges of a broad body, the inflection points lie very close to the edges. If the body is narrow (width less than twice its depth), the inflection points are outside the edges. Thus the anomaly outlines should enclose the body, and usually lie close to its edges.

At the end of this stage, all significant magnetic anomalies were recognized and marked on the maps. They had to be sorted and classified. Classification is based on two characteristics, amplitude and shape. Since strong magnetizations are concentrated in the crystalline basement, intrusive, and volcanic rocks (with the exception of some iron formations), strong anomalies, with relief of tens of gammas or more, must be caused by such rocks. These anomalies are called basement features in this report if they do not rise above the basement surface. Often the edges of such bodies are associated with structure at the basement surface, perhaps through faulting or differential erosion. Weak anomalies are more difficult to classify, since they may have a variety of causes. They may come from minor contrasts within the basement, from local rises of the basement surface or, in some circumstances, from sedimentary contrasts. The shapes of the anomalies may be used to differentiate these types. These weak features are called "above basement" anomalies in the interpretation, and are stippled on the maps.

The analysis of shape is part of the second stage of interpretation. The method used has been largely the Inflection Tangent Intersection or ITI method developed by the Compagnie Generale de Geophysique (Giret and Naudy 1963). The principal parameters that are measured are illustrated in Figure 1. These are based on the three inflection tangents, for bodies of moderate width, and the asymptote, or zero level of the anomaly. The tangents at the anomaly maximum and minimum are also used. The analysis is made in two parts, using horizontal and vertical measurements on the profiles. Five horizontal measurements may be used, $A_1 A_2$, $A_2 A_3$, and $A_2 A_4$, together with the peak and inflection point widths $T_1 T_2$ and $I_1 I_2$. These lengths are plotted on transparent logarithmic paper and compared with the calculated lengths of various theoretical models: two-dimensional dykes, extending to great depths, or lenses, which have limited vertical thickness, or step models or bodies with limited lengths. These master curves include a wide range of depth-width ratios and angles of dip or inclination. The comparison of field and master curves shows which model gives the best fit, and the depth to the top of the body.

A common difficulty in this process is choosing the proper zero level asymptote. This is now checked by vertical measurements from the tangent intersections to the curve, and the total relief of the anomaly, as shown in the illustration. Again a comparison with master curves shows the best fitting

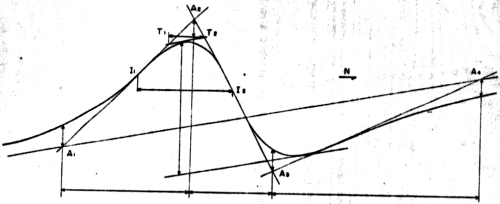

Fig: 1

PARAMETERS OF INFLECTION TANGENT INTERSECTIONS model, and its magnetization contrast. The measurements and analysis are revised to ensure that the two models, from vertical and horizontal measurements, are consistent.

In this interpretation, two principal problems have led to uncertainty with some anomalies. First, there is the problem of interference between closely spaced or superimposed anomalies. This has the effect of sharpening the flanks, and giving depth estimates that are too shallow. Second is the problem of selecting the proper model, especially in zones where there are numerous weak features. The difficulty lies in deciding whether a dyke or a lens or some intermediate shape should be used. It is illustrated by the normalized curves in Figure 2. At the top are a pair of symmetrical dyke anomalies, from models of different widths. The peak width (parameter T_1 T_2) would distinguish the two models. Below are a pair of lens anomalies, again distinguishable. But finally, the broader dyke and narrow lens are compared. The central portions of these anomalies are almost identical although their depths are very different. The key to distinguishing them lies in the outer parts, where the lens develops a negative effect. But this is exactly the part of the curve most subject to interference from neighbouring features. In practice it may be impossible to choose between the alternatives of a deeper lens or shallower dyke model. In this report, the dyke models have been used almost exclusively.

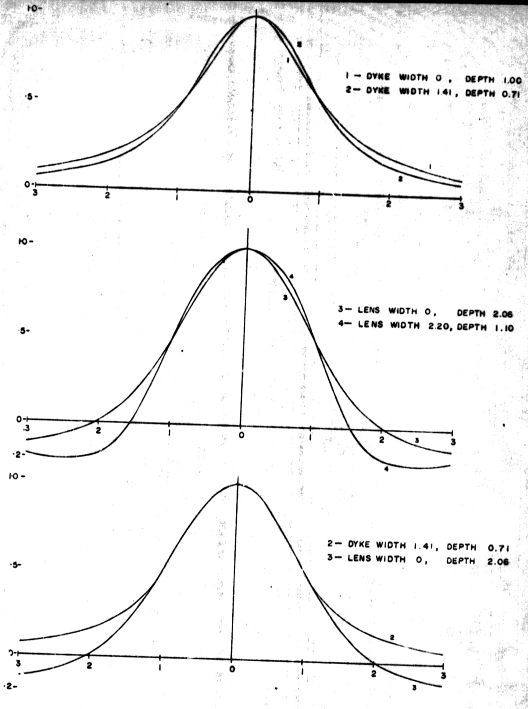

Fig: 2 : COMPARISON OF ANOMALIES FROM DYKES AND LENSES

In the final stage, the results are synthesized and related to geology. Consistency is a prime factor, both in terms of known geology and in relating one magnetic feature with another. Alternatives are reconsidered, for instance whether a given anomaly might be explained as coming from the basement surface or from within the sedimentary section.

In addition to the "basement" and "above basement" anomalies, two other groups of features are shown on the maps. One group are the deep-seated regional axes. These reflect changes of composition and are concentrated in the north half of the survey.

The second group are sharp minor features, and their peaks are shown by axis lines. Their sharpness implies that they are caused either by noise or by magnetic material near the surface of the ground. Undoubtedly some of them are noise effects, but not many. Results in other parts of Western Canada have proved the reality of similar surface effects, and here, their distribution in zones and persistent linear character would not support an explanation by a random noise pattern. It is difficult to explain the source of the magnetic material, but we suggest several possibilities. The material could be magnetic soil or superficial drift, in which case the anomalies are not significant. But it might reflect mineralization or minor intrusion, in which case it would be related to structure and faulting in the basement and sediments. Some of the surface features can be singled out as good indicators of possible structure.

A number of possible faults are shown on the maps following two criteria. Some follow dislocations in the magnetic pattern suggesting horizontal movement. Others follow linear flanks of magnetic features which are suggestive of faulting. Of course no distinction can usually be made between old intrabasement faults, which have no effect on the sediments, and others which have relief on the basement surface. Therefore, the faults are considered independently from the depth estimates. Deciding whether or not to mark a possible fault on the map is a subjective process, in a sense "high grading". Many other possibilities exist, and could be marked if faulting is suggested from other data.

INTERPRETATION

Sheets 1, 2 and 3

The magnetic pattern across these sheets has a curious perpendicular look, which is typical of the north half of the survey. There are broad east-west features, producing the east-west contours across sheet 1 and the western half of sheet 2. They culminate here in a pair of regional maximum and minimum axes. But on the eastern side, they are overridden by much sharper north-south features. Depth calculations yield 20,000 to 30,000 feet for the east-west axes, while the north-south features are shallower by a factor of ten, and are interpreted as coming from the basement surface. We wonder if the deep axes reflect a primordial precambrian basement, now buried beneath rocks which have been metamorphosed and intruded during the development of the basin, forming a new basement.

Basement Anomalies

The major disruption in the magnetic contours is caused by a north-south maximum in the north-east corner of sheet 2. This has a relief of over 50 gammas and arises from a change in composition in the basement rocks. Its linear form suggests a basic dyke, and a possible fault is marked along its western flank. Depth estimates imply a south dip along the anomaly, until it is abruptly cut off about latitude 65° 40'.

Another related feature begins with a broader anomaly in the north-west corner of sheet 3. This has a deeper source, within the basement. But from it a narrow linear anomaly extends south on sheets 2 and 5, again looking like a basic dyke at the basement surface. A similar linear anomaly was also found on sheet 3.

An anomaly of over 30 gammas lies just outside the survey boundary in the north-west corner of sheet 1. Presumably it is a basement effect.

The absence of basement anomalies on most of sheets 1 and 2 means that there is no control for extending depth contours across them. Basement depths on sheet 3 are probably close to 2000 feet below sea level.

Above Basement Features

The anomalies designated "above basement" on these sheets are generally north-south features with depths estimated in the range from sea level down to -2000 feet. Comparing them with the linear north-south basement features, the forms are usually similar, but the "above-basement" anomalies are weaker and give shallower depths. Two possibilities exist: that all the bodies are on the same surface and we have calculated falsely shallow depths by using the wrong models for interpretation (dyke instead of lens), or that two periods of activity are involved, one bringing magnetic material to the basement surface, and the second, later period, bringing smaller volumes into the sedimentary section. The interpretation shown on the maps is based on the second hypothesis, but both alternatives should be kept in mind.

On sheet 1, a scatter of minor anomalies obscure the picture, but one obviously deeper anomaly has been recognized and outlined. A similar pattern extends onto sheet 2, with lenticular "above-basement" features suggesting small dykes within the sediments. In the south-west, a marked magnetic negative lies between two of these anomalies and suggests a graben. In the south-east corner, one anomaly has a north-westerly strike. It could reflect a weakened continuation of the adjacent basement body, but calculated depths are considerably shallower. On sheet 3, anomalies are more frequent, and interference may be producing some false indications of shallow depth. This applies particularly to the anomaly in the south-west corner, which might well be a basement feature, related to the adjacent bodies to the north and west.

Possible Faults

Most of the possible faults on these sheets follow the flanks of linear magnetic anomalies, suggesting a basically north-south system of normal faults or tension fractures. There are some suggestions of transverse features. One extends north-east on the east side of sheet 2 through the end of the strong basement anomaly. Another is an east-west break in the north-west of sheet 2, following a marked offset in the anomaly pattern between lines 13 and 15. It is worth noting that the "above-basement" and surface anomalies both show offsets.

Sheets 4, 5 and 6

Although the dominant direction of the magnetic contours is north-south, regional axes can be traced right across these sheets from east to west. Depth estimates on the maximum range from 18,000 to 29,000 feet, with a steady deepening across sheet 5. It may also deepen on sheet 4, but the depths there are less certain, for the large peak is complicated by more interference from shallow sources.

Basement Features

The basement features can be split into two principal groups, some with the linear form characteristic of most basement effects throughout the survey, and others a more circular or peaked shape. Four may be put in this latter group. One very broad feature in the south-east quarter of sheet 5 could not be analysed because of other features superimposed on it. It may really be a sub-basement feature related to the original axes discussed above, and the huge maximum on sheets to the south. Immediately west, the magnetic contours show a sharp closure of some 75 gammas, probably reflecting a plug which is slightly elongated in a north-south direction. West of this again, another similar anomaly of some 50 gammas lies right on the survey boundary. The fourth anomaly in the group is a weak feature in the north-west corner of sheet 5, All of these anomalies give depths averaging a little over 3,000 feet.

Most notable among the other group are the 25 mile long anomaly on sheet 4, associated with similar features on sheets 2 and 8 to the north and south, and also a less persistent, but still long anomaly in the centre of sheet 5, which breaks up into sharp surface features to the north. Both are attributed to basic intrusives in the basement.

Depth estimates suggest a general basement surface at a level of 3,000 to 4,000 feet below sea level over most of the area. This rises to less than 2,000 feet in the north-east. A less pronounced and less certain basement high is suggested in the south-east quarter of Sheet 5, and a low at the south end of Sheet 4.

Above Basement Features

As on the sheets to the north, many of the "above basement" anomalies have a similar character to the linear basement features but are weaker and give depths of sea level to 2,000 feet below sea level. But here a number are associated with north-easterly trends. These include anomalies in the north-west and south-east quarters of Sheet 5, and in the north-east part of Sheet 4. These anomalies support the suggestions of north-easterly faults. In the north-west quarter of Sheet 5, additional support for the fault is given by an adjacent surface anomaly of about 1 gamma relief. This fault might extend to join another on Sheet 2. Similarly, the possible fault suggested in the north-east of Sheet 4 might be extended along the "above basement" anomaly flanks in the south-east of Sheet 5. These extensions would cross north-south features, suggesting that the latter are younger.

Minor Features

Two other near-surface anomalies near the western side of Sheet 5 are unusual for their strength, which approaches 10 gammas. They are marked A and B on the maps. Anomaly A, shown on three tie lines, has a very unusual strike. It lies over an obvious break, and possible offset in the mountains.

Do these features reflect minor intrusion along young fault planes?

Faults

As before, possible faults have been suggested along the flanks of linear basement and "above basement" features. In several places, minor surface anomalies support the suggested locations. This is especially so for the north-south fault in the centre of Sheet 5, where the associated axes have relief of some 5 gammas; and also for the north-east trending fault in the north-west corner of Sheet 5, mentioned above.

In the north-east corner of Sheet 5, another possible fault is suggested across breaks in the magnetic pattern. Again, some support is given by a short minor axis.

Sheets 7, 8 and 9

The magnetic contours over Sheets 7 and 8 are dominated by a huge maximum. Precise depth determinations are difficult, but the source is probably well over 30,000 feet below sea level. This body is related to the east-west regional axes to the north, but its orientation is perpendicular, conforming with the strike of the mountains. The conformity is extended by a pronounced nose developed to the south-east, on Sheet 8, marked as a regional maximum axis. The flanks of the huge maximum are steep almost to the point of obscuring weak anomalies, especially to the west.

Basement Features

Most of Sheets 7 and 8 show continuations of the type of basement feature found to the north, with one remarkably continuous body crossing Sheet 8 from north to south. It is obscured crossing the deeper-seated regional maximum axis suggesting some connection between the two features. Minor surface anomalies have been found parallel to both these major features near the junction. This could be evidence of minor mineralization along fractures over deeper structural trends, although correlations are not ideal, and some of the surface axes are uncertain. The north-south fault along the flank of the basement anomaly may also be reflected by topography near the south side of the sheet, where north-west trending hills are suddenly cut off.

Depth estimates along this anomaly show a consistent rise to the south and this rise appears related to another basement high over a similar feature to the north-east. Together these form a broad nose on the basement surface, enclosed by the 3,000 foot depth contour. A general level of 3,000 to 4,000 feet is expected to the west, although few depth estimates could be made there. Some figures suggest a gentle rise in the north end of Sheet 7, but this is not well defined. The low at the north-west corner of Sheet 8 is better controlled.

In the south-western corners of Sheets 7 and 8, a very different magnetic pattern appears, entering the front of the disturbed zone along the mountain front. The pattern developed is a continuous magnetic low, followed to the southwest by a discontinuous array of highs. The possible fault shown between them might be better called a boundary line. And strangely, this line lies about 5 miles northeast of the mountain front. On Sheet 7, the single basement anomaly behind this line appears to be below the general basement surface determined on Sheet 11 to the south.

Approaching Sheet 9, a remarkable series of north-south linear basement features has been mapped. Two strong and continuous magnetic maxima are outlined on Sheet 9, with subsidiary highs or shoulders developed along their outer flanks. The western maximum takes a sudden turn to the northeast at its north end, and could continue along the fault suspected on the southeast side of Keith Arm of Great Bear Lake.

In places these two maxima could be interpreted as a pair of roughly symmetrical peaks, suggesting nearly vertical basic bodies. But a strong low on the west side is obviously associated with the adjacent maximum. Furthermore the profiles around lines 151 and 153, where the eastern peak has died out, present a classic picture of the antisymmetrical anomaly, with nearly equal maximum and minimum. This must be interpreted as the western edge of a nearly horizontal sheet of basic rocks; like the edge of a sill but on a large scale. Extending this picture through the regions where two maxima appear, it is possible to interpret the western peak as the edge of a sheet, with gradually steepening dip to the east as we go south and the eastern peak as a near vertical dyke shaped body. But since the magnetic anomaly of a vertical thin sheet has exactly the same form as a symmetrical folded sheet or an anticlinal axis, it may not be necessary to imagine a vertical body intruding the horizontal sheet. Both geologically and geophysically, it is reasonable to interpret the western pair of high-low axes as the edge of a near horizontal body, and the eastern high axis as the crest of a fold in the same body. Where the edge curves to the northeast, the folding dies out.

Great differences in depth determinations appear if the anomalies are interpreted as nearly horizontal or nearly vertical bodies. Unfortunately the depths from horizontal bodies are critically dependent upon the thickness of the body. To develop some consistency in the results, the Peters half slope method has been applied, dividing the measured length by a factor of 1.6. This is equivalent to assuming a thickness of about 3 times the depth to the top. This may be too great, for it implies a thickness of 15,000 to 20,000 feet. A reduction in thickness to equal the depth to the top would increase the sub-flight depths by a factor of 1.23, or with small thickness, by 1.60. Such increases would place the body well below the basement surface determined elsewhere. The present results do make a coherent pattern across Sheet 9 with basement depths increasing from less than 2000 to more than 4000 feet to the northwest. This develops a basement low running northeast, and turning into the topographic low beneath Keith Arm.

Subsidiary anomalies develop with the major basement features. One is a long and narrow outline on the eastern edge of Sheet 8. This is probably quite spurious, following the hump which must develop on the flank of the minimum axis immediately to the east. But a genuine anomaly appears along the same line in the southeast corner of Sheet 8, apparently over a near-vertical basic rock body.

On sheet 9, a shoulder on the flank of the eastern maximum axis is outlined as a separate basement feature, possibly reflecting a second, minor, fold axis in the horizontal sheet.

A major change in the magnetic pattern on Sheet 9 occurs along a line running southeast from the apex of curvature of the western maximum axis. This is marked as a possible fault or boundary zone. Northeast striking anomalies develop northeast of this line, and one long narrow feature may follow a small dyke at the basement surface.

Above Basement Features

Among the "above basement" features outlined on these sheets, two groups form trends that may be important. One is a series of small features aligned north-south on Sheet 7. Their discontinuous appearance may reflect the difficulty of recognizing weak anomalies on the flank of the huge maximum. A second set of longer anomalies runs north-northwest across the northeast part of Sheet 8. They do not exceed four gammas in amplitude, but follow a boundary of a region to the northeast that contains a large concentration of "above basement" anomalies, many with northeast strikes. A possible fault is suggested along this boundary, and the "above basement" anomalies along it could indicate minor intrusion along the fault plane.

On Sheet 9, two "above basement" anomalies are outlined on shoulders of the west side of the major north-south maximum. These could reflect separate bodies rising above the main mass of basic rock, but more likely they show irregularities along its edge.

Minor Features

In the southwest corner of Sheet 8, there is an extraordinary concentration of minor anomalies with north to northwest strikes. They seem to be related to the Franklin mountains both in proximity and direction. Their continuity and amplitudes of a few gammas suggest minor mineralization and possible association with faulting or structure. The sudden vanishing of these features to the north may indicate changing behaviour of the sediments.

In the extreme east of Sheet 9 a number of sharp anomalies of shallow origin strike northeast. These all lie northeast of a possible fault or boundary line and support the idea of different structural patterns on the two sides of this boundary.

Faults

The northeast striking possible faults on the east side are probably the oldest in this area. One is cut off by a northwesterly boundary or possible fault. The other curves into a north-south feature along the flank of the horizontal sheet discussed previously.

Other possible faults follow north to north-northwest flanks of basement and "above basement" features and the boundary of the disturbed zone in the southwest. These have already been discussed.

One minor fault is suggested striking northeast in the centre of Sheet 8. It is based on three pieces of evidence: A slight change in strike of the basement body to the northeast; the flank of an "above basement" anomaly and a parallel minor axis; the discontinuity of a perpendicular minor axis which appears on lines 163 and 165 but not on tie line 349.

Sheets 10 and 11

Regionally, three areas with different magnetic contour patterns may be distinguished across these sheets. In the southwest corner a large magnetic minimum, striking northwest, marks the edge of the disturbed basement associated with the Franklin mountains. Southwest of this minimum, the pattern is very disturbed. A second region across the centre of Sheet 11 has smooth and steep magnetic gradients between this minimum and the huge maximum centred on Sheet 8 to the north. Then over Sheet 10 and the eastern third of Sheet 11, a number of basement anomalies appear, forming a third region.

Basement Features

The continuity of the magnetic minimum axis in the southwest part of Sheet 11 contrasts with the irregular peaks in the disturbed magnetic pattern to the southwest. The possible fault drawn between the minimum and the peaks probably marks a boundary zone or hinge line. Basement to the northeast is relatively undisturbed, but much intrusion and metamorphism occurs to the southwest. The boundary zone lies some 5 miles northeast of the mountain front. If it reflects the same thrust faulting as the mountain front, we could expect it to lie on the other side, to the southwest. Hence it seems more likely that the basement boundary has controlled the location of the mountains, rather than vice versa. In any event, the character of sedimentary structure is likely to be quite different on the two sides of this boundary. Basement depth estimates in the disturbed area are erratic, partly due to the irregular forms of the magnetic features and the uncertainty of strike corrections. The figures range from -1900 to -4600 feet, and it seems reasonable to interpret a high area to the southwest, with a 3000 foot contour close to the boundary of the region.

The long basic rock body on Sheet 8 has a clear extension over Sheet 11, where relief exceeds 30 gammas. The 4000 foot depth contour fits this body quite well but is poorly controlled in the centre of the sheet.

Proceeding east onto Sheet 10, there are continuations of the pattern from Sheet 9 discussed previously. But in this region there are significant changes as the larger western maximum axis weakens and the minimum on its western side almost disappears. The horizontal sheet of basic rock seems to be developing pronounced east dip as we proceed south. This gives uncertainty to the depth estimates, and alternative sets are shown on one anomaly, interpreted on two hypotheses. We prefer the set along its flank, averaging about 5000 feet, rather than the shallower set, near 3000 feet along its axis. This preference is partly based on the replacement of both the eastern and western maxima by a single strong symmetrical maximum at the south boundary of the survey. Relationships are not clear, but this final feature seems to be a basic body well below the basement surface. Possibly it reflects part of the pluton which was the source of the horizontal sheet of basic rock.

A broad and poorly defined anomaly lies at the north-east corner of Sheet 10, reflecting a change of composition at or below the basement surface.

Above Basement Features

Several weak anomalies in this region yield moderate depths and are classed as "above basement" features, but their immediate significance is not apparent.

Minor Features

There is a high concentration of sharp minor anomalies or noise in the southwest corner of Sheet 11. Few could be followed from line to line with certainty. One of these, Marked C, is relatively strong, averaging 5 gammas relief, and may well reflect minor mineralisation or intrusion.

SUMMARY AND CONCLUSIONS

The aeromagnetic data has been used to interpret four different magnetic horizons within the survey area. These are:

1. A deep horizon, from 20,000 to more than 30,000 feet, reflected by east-west regional axes in the north half, and a huge north-south magnetic maximum together with a northwest-

southeast axis on Sheet 8. This could follow a primordial basement surface, or perhaps intrusive and metamorphic activity within the basement.

2. Basement, at depths from less than 2000 to more than 4000 feet below sea level. Through most of the area, the basement anomalies are linear north-south features. These reflect near-vertical, relatively narrow basic rock bodies, with one notable exception in the south-east, on Sheets 9 and 10 where an almost horizontal body has been interpreted. The geological nature of this body is difficult to understand, since it appears to cover a large area to the east and to have a thickness of thousands of feet. Additional anomalies to the east may indicate folds or rises of its upper surface. Along the southwest edge of the survey, on Sheets 7, 11 and possibly 5, a very different type of basement has been found with irregularly shaped bodies. This is associated with the mountain front, but the disturbed basement zone extends some five miles beyond the mountains. The difference in location implies that the basement disturbances controlled the location of the mountains. Finally it is important to recognize the absence of magnetic features from the basement surface in large parts of the survey area, notably in Sheets 1, the west half of Sheet 2, the northwest part of Sheet 5, Sheet 6, and large portions of Sheets 7 and 8. Basement there, is remarkably uniform in composition.

3. Above Basement. A large number of weak anomalies give depths from sea level down to some 2000 feet below sea level. Many of them form long trends running roughly north-south, giving

the appearance of small dykes. But an alternative interpretation is possible, using lens models of limited vertical extent, and this could place the anomaly sources at or close to the basement surface. The dyke alternative is preferred on two counts: because it seems more plausible geologically, and because it would be most dangerous to pursue exploration without this possibility kept foremost in mind.

4. Surface Effects. Numerous anomalies are so sharp that they must come from near the surface of the ground. Many have been correlated from line to line and form apparently linear trends. Although some of them are undoubtedly noise effects, the continuity, the arrangement in zones, and the parallelism to stronger and deeper seated anomalies, supports the idea that many of these features are both real and related to underlying structure. The source of the magnetic material involved is uncertain, but it might come from minor mineralization penetrating the sediments or sometimes from minor intrusion. The surface effects obscure recognition of deeper anomalies in some places.

Reviewing these four magnetic horizons raises a serious question of definition. Has the basement been correctly identified, and what, indeed, is the correct definition of basement in this area? The basement depth contours are based on estimates to the top of one set of basic rock bodies, assuming a smooth surface between them. Other interpretations are possible. At one extreme these bodies could be considered as intrusives penetrating the sediments, with the basement at an undetermined depth below them. A similar situation exists in the Arctic

Archipelago where dykes and intrusive rocks in domes have penetrated tens of thousand of feet of sediments. At the other extreme, the basement surface might be drawn through points determined from the "Above basement" anomalies, meaning that some of the bodies now considered at the basement surface are actually below it. This would be unusual, in that it is rare to find a basement reflected only by weak anomalies, with its magnetic materials concentrated below the basement surface. This is likely only when basement is defined as the top of weakly metamorphosed rocks.

A number of possible faults are drawn on the maps, based on several different criteria. They may follow the edges of long continuous magnetic anomalies or breaks and offsets in the anomaly pattern. In many cases, it is difficult to choose between drawing a fault on one side of a body or the other, and both possibilities should be kept in mind. Some might be better called boundary zones rather than possible faults, for they separate areas of different basement character.

Among the possible faults, perhaps the oldest group may strike northeast. Only a few of these have been recognized, one group on Sheets 2, 3, 4 and 5 and another on Sheet 9. These are generally on the east side of the survey and may be extensions of parallel features from the Precambrian shield to the northeast. They tend to be cut off, overridden or obscured by stronger, and probably younger features striking generally north-south. This second group is the dominant set so far as structure within the basement is concerned. And in view of the structural history of the area, it would be surprising if the sediments did not reflect such strongly marked basement features. Most of the possible faults in this group form a zone through the centre of the area from Sheet 2 down to Sheet 9. The parallel faults interpreted on Sheets 9 and 10 may form a subgroup, for they are related to the horizontal sheet mentioned above perhaps involving a different type of structure. Finally there are two northwest striking possible faults which mark boundary zones between different basement regions. The boundary effect is obvious in the southwest corner of the survey where it is associated with the mountain front and less clear for the feature on Sheet 9.

The results of this aeromagnetic survey show many interesting possibilities for further exploration. They should be used to guide further work, and then to correlate results so that an integrated picture of basement, subsurface and surface geology and structure can be assembled.

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