4 F - 1 - 5 - 2

Reconnaissance Macro-Fracture & Geomorphic Analysis

Franklin Area, Northwest Territories.

GEOPHOTO SERVICES LTD.
GEOPHOTO
CALGARY, ALBERTA, CANADA

RECONNAISSANCE MACRO-FRACTURE AND GEOMORPHIC ANALYSIS

of the

FRANKLIN AREA, NORTHWEST TERRITORIES

Prepared for

SINCLAIR CANADA OIL COMPANY

By

GEOPHOTO SERVICES, LTD.

Calgary, Alberta.

November, 1966.

TABLE OF CONTENTS

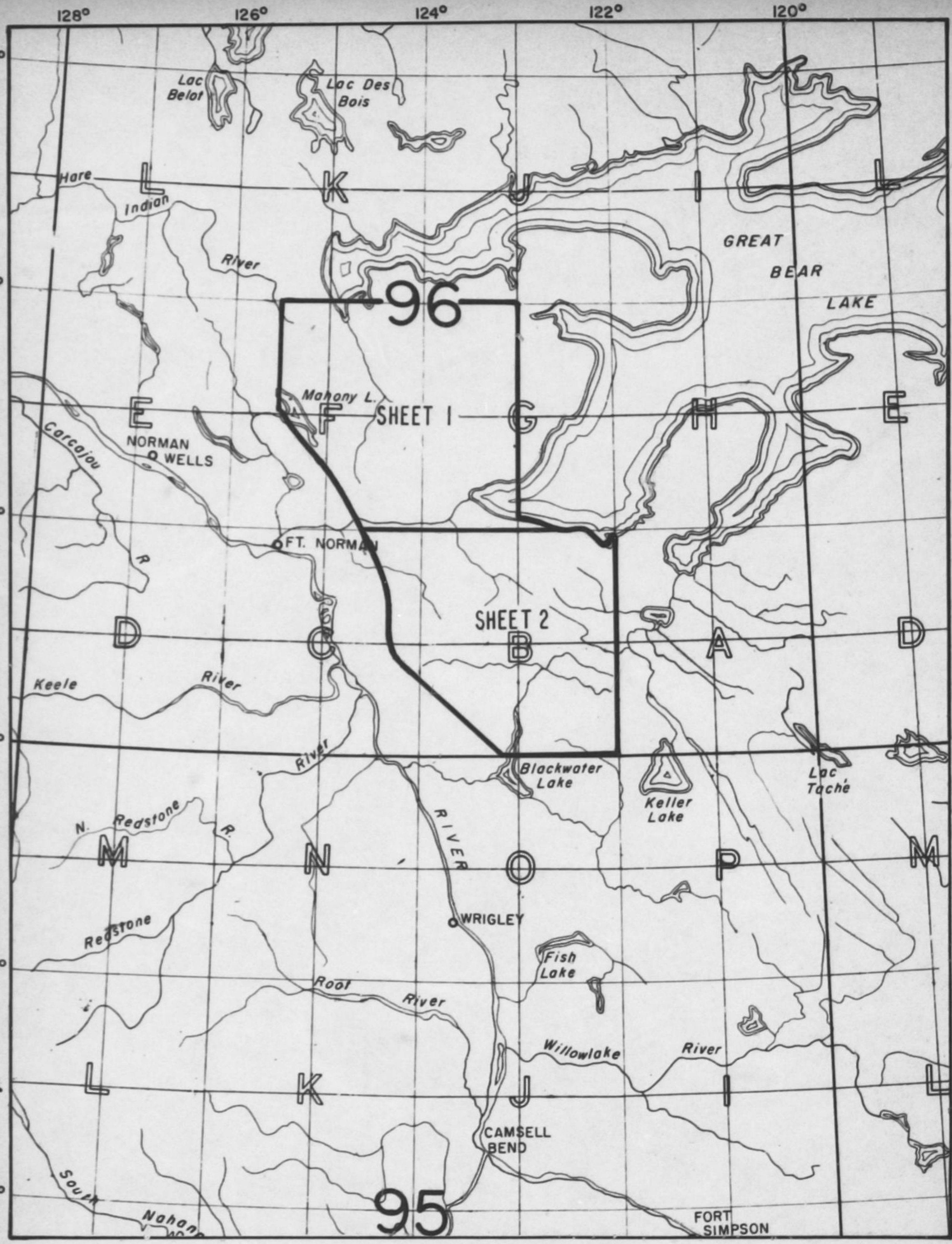


Plate I

REGIONAL LOCATION MAP

FRANKLIN AREA
N.W.T.

SCALE: 1inch = 40miles

INTRODUCTION

This report describes the results of a reconnaissance macro-fracture and geomorphic analysis of the Franklin Area, Northwest Territories (Plate 1). The total area analyzed is approximately 8,500 square miles. The Franklin area covers portions of National Topographic System areas 96 B, C, F, and G. This area extends from Lat 64° to 66°N and from Long 122° to 125°30' W. It is bounded on the east by the Great Bear Lake and on the west by Franklin Mountains.

This study has been undertaken for the purpose of delineating and interpreting geomorphic and macro-fracture data which are believed to reveal details of subsurface geology. The geomorphic and macro-fracture analyses were conducted independantly. The conclusions of the separate studies have been integrated into a final Summary and Conslusions. It is believed that where anomalous conditions of one study are found coincident with the other, additional confidence is allowed for the joint interpretation. It should be pointed out that the interpretations contained in this report are based solely on the results of the geomorphic and macro-fracture analysis without aid of subsurface data. An attempt has been made to correlate and project anomalous geomorphic and macro-fracture features into similar features in the adjoining mountains through the use of a photogeologic study prepared for Sinclair Canada

Oil Company by Geophoto Services, Ltd. (1963).

PHOTOGRAPHY AND MAP COMPILATION

Photography

The vertical Panchromatic air photographs used in preparation of the Franklin area mosaics, were flown by the Canadian Government in 1949. All photographs were taken with cameras equipped with a six inch focal length lens which has provided a scale of 1:35,000. Flight lines were flown in a north-south direction. The photographs have been tonally matched in printing by the Federal Government and are considered good quality.

Mosaic

An uncontrolled, stapled mosaic was prepared by Geophoto Services, Ltd. The mosaic was constructed by carefully matching details of alternate photographs along flight lines, using topographic and hydrographic features for control. The mosaics were reproduced photographically at a scale of one inch equals two miles. National Topographic maps at a scale of 1:250,000 were utilized for mosaic control.

Map Compilation

The base maps were prepared by enlarging 1:250,000 National Topographic Maps and transferring detail to permascale sheets, at a scale of one inch equals two miles.

Significant fracture and geomorphic data were drafted onto the permascale copies of the base maps. Ozalid prints of the permascales comprise the final maps. The maps have been designated as Sheet 1 for the northern part of the project area, and Sheet 2 for the southern part of the project area.

REGIONAL GEOLOGY

Location

The project area is entirely within the Interior Plains Physiographic Province (Bostock, 1948, p. 3). This is an area of relatively undeformed sedimentary strata lying between the Canadian Shield and the Franklin Mountains. The Precambrian Shield is located approximately 144 miles to the east and the Franklin Mountains form the western boundary of the project.

This region is mantled by glacial drift and proglacial lake deposits. There has been very little data published on the underlying deposits in this area; however, it is believed that the glacial mantle generally overlies Lower Cretaceous strata throughout much of the project area. The highlands north of Fort Franklin, here termed the "Franklin Hills" may contain Upper Cretaceous or Tertiary strata which has formed a cap rock and retarded preglacial erosion in the vicinity of these hills. The Franklin Mountains, on the west, contain a sequence of strata extending from Cambrian to Middle Devonian in age. A hiatus occurs in the stratigraphic sequence from Middle Devonian to Lower Cretaceous. The thickness and stratigraphic relationship of the various rock units exposed in the Franklin Mountains have been discussed in a previous study (Geophoto Services, Ltd., 1963).

Quaternary

The Franklin area is mantled by Pleistocene glacial drift and proglacial lake deposits. The few incised streams and deep glacial grooves may slightly penetrate bedrock strata. Some outwash deposits, particularly in the north part of Sheet 1, and eskers, scattered throughout the area, probably contain stratified till. Ice-disintegration features are wide-spread in the southern part of Sheet 2 where features, such as ; lateral moraines or ice-disintegration ridges and terminal or end moraines are present. These features probably represent only local and temporary ice stagnation. The few eskers shown on the Geomorphic Analysis Maps may be a good source of gravel. More eskers than shown are undoubtedly present.

Wide-spread glacial grooves are the most prominent physiographic features within the project area. These grooves are generally quite deep, quite wide and relatively long. They may be steep walled, "U"-shaped or "V"-shaped in cross-section. Individual grooves may exceed 18 miles in length. The top of the grooves range in width from approximately 300 feet to approximately 1,000 feet. It is generally accepted that glacial grooves are good indicators of ice-flow direction. In the project area the grooves are restricted to lower topographic areas and trend northwesterly except where deflected around higher topography. The ice movement is believed to have been controlled by the Franklin Mountains. Deflection from the regional trend has occurred in the vicinity of Blackwater Lake, on the south end of Sheet 2, where the northerly flowing ice was deflected westward and then north-eastward, back into the glacial path, on the south end of a small topographic rise east of Blackwater Lake or westward and then southwestward around the topographic high. Another deflection from regional trend has occurred where the Great Bear River crosses the Franklin Mountains. Sharply defined grooves trend westerly immediately west of this gap in the mountains. These grooves have been studied in the field by Smith (1948). Smith has found, at this location, that the grooves are more than 300 feet wide and 8 miles long. Smith (1948, p. 508) has suggested that: ..."Where the grooving is strongly developed, it is inferred that the amount of erosion was equivalent to the removal of a layer of rock having a thickness of from 40 to 80 percent of the relief of the grooves" ... He further points out that groove location and orientation are indifferent to structural axes. Smith (1948, p. 509) has found that the grooving is strongly influenced by lithology. He points out that (In Mackenzie Basin): ..."In massive Silurian limestones, no grooving was found. In the brecciated and porous to cavernous Bear Rock Formation, the grooves attain maximum depth" ... The grooves are said to be of large size and poorly indurated Devonian limestones and the scale of grooving is smaller in harder Devonian limestones. Smith claims that where grooving can be recognized in shale and poorly consolidated sandstones it is more rounded and subdued. Smith (1948, p. 511) has found no relationship between grooves, and joints and fractures.

The northwest trending grooves fit the regional ice flow pattern as shown by many authors (Flint, 1957, p. 315; Craig and Fyles, 1960, p. 412). These indicators suggest that the grooves were formed by ice advancing from (or retreating to) the Laurentide Center of accumulation west of Hudson's Bay.

The appearance of the glacial grooves is accentuated by small oriented lakes. The lakes are generally elongate, wider at the southern end than at the northern end, and parallel to the groove pattern. In many cases the southern end of the lakes trend perpendicular to the grooves and are extremely linear.

There has been a great deal of speculation about the origin of oriented lakes in Arctic North America (Mackay, 1963; Carson and Hussey, 1962). Theories have included wind and wave action, meteor showers, and fault control to name but a few. The area of this report is some distance south of many areas covered by the above speculative theories. However, the author suggests that the origin of the oriented lakes is probably quite similar in most northern areas and quite different from previously proposed theories.

It appears obvious that the oriented lakes in the Franklin area are controlled by glacial grooves. It is here suggested that the groove shape strongly controls the elongate triangular lake shapes. Since most of the grooves appear to have "U"-shaped or "V"-shaped floors a triangular or pointed lake should result where there is a gradient to the groove bottom. Smith (1948, p. 509) pointed out that grooving appeared most succeptable on the stoss sides of topographic slopes. Therefore, it may be postulated that where grooving is most prominent west of Great Bear Lake, that the initial topographic surface sloped to the south or southeast. A similar gradient probably is present in most of the grooves, as indicated by stream flow. Therefore, the apex of triangular lakes may point up-slope of the ancient bedrock surface. The linear ends of the lakes may be the result of prevailing northerly winds; linear changes in paleotopography; or more than likely, small ice-disintegration ridges. Further north where similar lakes are present on the Arctic Coast and Mackenzie Delta, the lakes have had a similar origin. Those areas were probably submerged by high sea level near the end of glaciation and other common glacial features may have been removed at that time. After emergence, only glacial grooves remained and are now occupied by the oriented lakes.

Great Bear Lake was probably formed as a proglacial lake in a preglacial topographic depression. According to Craig and Fyles (1960, p. 413) this lake joined with Great Slave Lake to the south. It may have included Blackwater Lake as well.

floors a triangular or pointed lake should result where there is a gradient to the groove bottom. Smith (1948, p. 509) pointed out that grooving appeared most succeptable on the stoss sides of topographic slopes. Therefore, it may be postulated that where grooving is most prominent west of Great Bear Lake, that the initial topographic surface sloped to the south or southeast. A similar gradient probably is present in most of the grooves, as indicated by stream flow. Therefore, the apex of triangular lakes may point up-slope of the ancient bedrock surface. The linear ends of the lakes may be the result of prevailing northerly winds; linear changes in paleotopography; or more than likely, small ice-disintegration ridges. Further north where similar lakes are present on the Arctic Coast and Mackenzie Delta, the lakes have had a similar origin. Those areas were probably submerged by high sea level near the end of glaciation and other common glacial features may have been removed at that time. After emergence, only glacial grooves remained and are now occupied by the oriented lakes.

Great Bear Lake was probably formed as a proglacial lake in a preglacial topographic depression. According to Craig and Fyles (1960, p. 413) this lake joined with Great Slave Lake to the south. It may have included Blackwater Lake as well.

Evidence of possible isostatic rebound is present on the "Franklin Hills" northeast of Fort Franklin where lake terraces and strand lines are well developed. The uppermost terrace is about 440 feet above the present lake level. This figure correlates well with the estimates of 400 feet by Craig and Fyles (1960, p. 413). They also suggest isostatic readjustment of 300 feet (Craig and Fyles, 1960, p. 414) along the northeast part of Great Bear Lake. Three hundred feet seems to be a fairly uniform figure for isostatic rebound throughout the north. Muller and Barr (1966, p. 268) have found total isostatic uplift for northeastern Devon Island to be approximately 110 meters (361 feet) and the author has found approximately 300 feet of uplift south of Zama Lake in the Rainbow area of northern Alberta. Some of the discrepencies in isostatic rebound may be attributed to differential rates of uplift and lowering of lake levels.

One of the most important terrain features in the Franklin area is muskeg which undoubtedly covers most of the region. In the vicinity of lakes and broad streams, floating muskeg is probably prevailent.

MACRO-FRACTURE ANALYSIS

General Remarks

The macro-fracture analysis was undertaken for the purpose of delineating and interpreting macro-fracture data which is believed to reveal details of subsurface geology. In this report, the terms "macro-fracture" and "lineament" are used interchangeably (see Glossary). Lineament density patterns may reveal abrupt facies changes, subsurface structures, and/or horsts and grabens on the basement surface. Very distinct lineaments of considerable length, are frequently found to be the surface expression of major Precambrian basement faults or zones of weakness along which later movement has occurred. Other principal lineaments may be due to post-Precambrian faulting; basement structure or topography; Paleozoic topography; linear zones of differential compaction over subsurface structures, or competent beds; or abrupt facies changes.

Macro-fractures, or air photo lineations, are defined as large, composite, more or less discontinuous natural lineations exceeding two miles in length. Although glacial grooves are natural lineations and may be structurally controlled, they are not considered macro-fractures and are not annotated as such. Macro-fractures are generally well expressed on air photo mosaics of the project area. They are best observed by viewing the mosaic at a low angle, under intense light conditions. Individual lineations which collectively form a macro-fracture or photo lineation, are usually soil, tonal and vegetal changes readily apparent on the air photographs but seldom visible on the ground. In some cases, prominent macro-fractures may be expressed by linear stream courses or linear topography. One example of a linear stream course contributing to the overall photo-lineation can be seen along the Great Bear River. Another example might be the very distinct macro-fracture trending N50°E on Sheet 2 which is postulated to continue southwestward across the Mackenzie Basin where linear courses of the Redstone River and the Dahadinni River may contribute to the overall macro-fracture interpretation.

The quality of fracture analysis depends on the quality of the photo mosaic, the land surface conditions, and the complexity of factors controlling fracture generation. The most favourable conditions are believed to exist in areas of little structural deformation, with some block faulting, and with little or no cultivation. The present study area is not especially favourable for fracture analysis. The strong glacial groove pattern, numerous lakes, and floating muskeg probably combine to obscure many fracture traces. The glacial grooves and perpendicular trending inter-groove drainage patterns tend to give an eroneous fracture pattern. Where these features can be identified they are usually so well expressed as to obscure natural lineations and an anomalously low fracture trend will be found in those directions. It was surprising in the final analysis of the macro-fracture data, that the glacial grooves and lakes were not outlined by the fracture density pattern.

An inherent problem in fracture analysis is the "edge fall-off effect" which often results in a low fracture density along the edges of a project area or around large lakes. "Fall-off" results from not being able to trace lineaments beyond the mosaic edge or beyond the shoreline. Consequently, some lineaments which barely enter the map area and should be annotated, cannot be recognized without studying photographs beyond the project boundary. In this project some fall-off undoubtedly accounts for the low fracture density along portions of the boundary and around Great Bear Lake.

Macro-fractures observed on the air photographs are believed to be a direct sampling of the fracture system present in the underlying bedrock. The fractures are generally considered to be vertical, although deviations from vertical dip may occur in folded strata. Fractures are thought to be propagated upward, through the surficial cover by minor earth movements such as seismic activity, earth tides, isostatic rebound, differential compaction, or a combination of the above. Continuous propagation of existing fractures upward through successively deposited layers was postulated by Plafker (1964, p. 519). Plafker suggested that block faulting or differential compaction of unconsolidated deposits over bedrock fractures could produce several surficial depressions along linear trends. The differential compaction of unconsolidated sediments may result from recurring vibrations or oscillations in the Earth's crust or the differential influence of the force of gravity of sediments deposited over competent subsurface features, such as; reefs, folds, fault blocks, or abrupt facies changes. Plafker further pointed out that differential compaction of only 8% in a layer of sediment originally 50 feet thick would result in a surface depression 4 feet deep. It is interesting to note that fractures are often better developed in recently deposited, unconsolidated sediments such as dry lake beds or river flood plains, than in adjoining bedrock or glacial drift. This would seem to indicate that many of the lineaments have been active during most recent times.

The Macro-Fracture Analysis was carried out by annotating lineaments directly on four, clear acetate overlays called "Original

Data Sheets". Each Original Data Sheet contains all lineaments lying within a 45 degree sector. Each sector was analyzed by inspecting 15 degree segments at a time. The lineaments have been annotated in two categories; very distinct lineaments (heavy solid black line) and indistinct or faintly expressed lineaments (fine solid black line). Lineaments are categorized by determining their relative photo expression. Very distinct lineaments have been selected by viewing the mosaic at various angles under differing light conditions. The very distinct lineaments are generally so well expressed as to be apparent to the untrained eye. The indistinct or faintly expressed lineaments comprise by far, the greatest number of macro-fractures annotated on the Original Data Sheets. The indistinct lineaments are well described by their name. They are usually only recognized by concentrated viewing of the mosaic under intense light at a low eye to mosaic angle. Many lineaments are shown on the Macro-Fracture Analysis Maps. These lineaments have been classified as very distinct (heavy line) macro-fractures, and distinct (light line) macro-fractures. These categories are merely a means of delineating the interpreted relative importance of the various lines shown and have little relation to their true photo expression as plotted on the Original Data Sheets, other than that they were originally plotted as very distinct macro-fractures in most cases. The very distinct macro-fractures shown on the Macro-Fracture Analysis Maps are thought to be the most significant lineaments in this region and have been further interpreted to be Precambrian basement faults or zones of weakness. Additional subsurface information may show that some of the lineaments annotated on the final maps as distinct lineaments may be as important as the very distinct macro-fractures. The indistinct or faintly expressed macro-fractures, by weight of greater number, generally comprise the fracture density patterns.

Macro-Fracture Density

The macro-fractures plotted on the acetate work sheets show patterns of high and low density. The fracture density contour map was prepared in order to facilitate the recognition of high and low lineament density. Three ranges of fracture density are noted and are classified as high density, intermediate density and low lineament density.

The four Original Data Sheets, in register, were placed over a sheet containing one inch (four square miles) grid squares. The density is lineaments was determined by counting each of the lineaments intersecting the grid square. This value is a function of the total length of lineaments contained within each grid square. The density value was then contoured. Low lineament density (green) was arbitrarily set at the 8 contour interval and below. The high lineament density (red) was arbitrarily set at the 12 contour interval and above. Those values lying between 8 and 12 lineaments per grid square are considered intermediate density (white). Very high lineament density (16 and above) zones have been colored purple in order to facilitate their recognition.

A fracture density pattern may reflect both changes of structure and stratigraphy. As a general rule, it is believed that macro-fractures are more likely related to structural deformation and the density variations are thought to outline the subsurface topography. It is thought that the indistinct lineaments which comprise by far the greatest number of lineaments annotated, are probably representative of fractures and joints caused by differential compaction. In which case, a high fracture density pattern can be expected to occur on the flanks of subsurface highs and lows and along the margins of abrupt facies change. Therefore, intermediate and low fracture density patterns will be located over subsurface highs or lows or over a zone of competent strata. These generalized theories will be modified by the magnitude of the subsurface features involved. Previous work by Geophoto Services, Ltd., has shown that a high density macro-fracture pattern is often developed on the periphery of reefs or folds with a low fracture density pattern extending over the reef or along the crests of the fold, consequently over the producing area. It has been impercally found that actual crude oil production has been obtained, approximately 90% of the time, from areas of intermediate to low fracture density. It has been generally found that a smaller percentage of gas fields occur in the low and intermediate zones. Although they do appear to favour the low and intermediate fracture density patterns.

A Gross Interpretation Overlay to the Macro-Fracture Analysis Maps has been prepared. This overlay was constructed by a generalized form-lining technique of the areas of high and low fracture density. This technique tends to better outline specific trends within the fracture density pattern and also helps to overcome minor localized influences such as grooves and lakes. The fracture density trends have been delineated by constructing trend lines or density axes. The trend lines may represent significant subsurface changes. The low fracture density trend line may represent significant facies variations which may be caused by paleotopography, such as ancient shorelines, reefs, or Paleozoic stream channels; they may represent the axes of subsurface synclines or anticlines; or they may indicate zones of basement block faulting. A high fracture density trend line may represent zones of maximum subsurface change either on the flanks of subsurface highs and lows or abrupt changes in lithology, where differential compaction has created a number of small fractures or faults. On the Gross Interpretation Overlay, the low and intermediate fracture density trend axes are shown as a heavy dashed line and the high fracture density trend axes are shown by a heavy dotted line.

Certain anomalous patterns have been selected on the Macro-Fracture Analysis Maps in conjunction with the Gross Interpretation Overlays. They are indicated by capital letters and are described in the following paragraphs. The interpretations given for each anomaly must be considered tentative because all possible conditions resulting in a fracture density pattern are not known. The more detailed, and more correct interpretation of the fracture data will be possible only with additional subsurface information. At this stage of the interpretation, the Geomorphic Analysis has not been incorporated into the overall interpretation. This aspect of the study will be undertaken in the Summary and Conclusions. It is extremely important that in order to gain full utilization of Macro-Fracture Analysis Maps, they must be compared and studied with other subsurface maps on a continuing basis as new information becomes available. It is further recommended that each of the Original Data Sheets be separately correlated with subsurface information. It has been found in other areas, that significant information can be so obtained, particularly where terrain influences may have altered the fracture pattern.

Macro-Fracture Anomalies

Sheet 1

Anomaly "A" - Anomaly "A" consists of a low fracture density zone apparently trending northwesterly. The anomaly is bounded on the east by a high fracture density pattern. The low fracture density trend may continue southeastward and join with a similar trend north of Anomaly "C_2". However, it is interpreted to terminate at approximately Lat 65°50'N, where it may intersect a northeast trending feature designated as Anomaly "B". Anomaly "A" may represent a subsurface high. Edge fall-off may account for the low fracture density zone immediately west of the designated anomaly, thus giving the apparent northwest trend.

Anomaly "B" - This anomaly is a northeast trending, intermediate to low fracture density zone, surrounded on the northeast by an arcuate high fracture density pattern. It has been imperically found that such an arcuate high fracture density pattern often delineates the edge of a subsurface high located on the concave side of the arcuate pattern. If a fracture density axis was drawn in a more east-west direction, it would join with an anticline, shown on a previous photogeologic study (Geophoto Services, Ltd., 1963), which trends westerly through the project boundary at approximately 65°42'N Lat.

Anomaly "C" - Anomaly "C" has been designated in two parts in order to show the large aerial extent of this low and intermediate fracture density pattern. The overall trend of this anomaly appears to be northerly; however, fracture density trend axes have been drawn through low fracture density patterns in a north-northwesterly and a north-northeasterly direction. If Anomaly "C" is representative of a subsurface feature, the trend of this feature may be north - south, generally parallel and close to the very distinct macro-fracture trending N10°W through Anomaly "C_1". Lakes and glacial grooves have probably obscured structurally controlled photo lineaments in the vicinity of this anomaly. Therefore, intermediate fracture density patterns, within the anomaly, may be correlated with high fracture density elsewhere on the map sheet. If this is the case, then the northeasterly and northwesterly trend axes may represent subsurface features. The axis trending northwesterly from Anomaly "C_2", is generally parallel to observed outcrop areas to the west. The northeast trending axis from Anomaly "C_2" may then indicate cross-structural features related to earlier Paleozoic tectonics and the junction of these two axes may be the locus of a subsurface positive feature. The southeast part of Anomaly "C_2" appears to be bounded by a series of northeasterly trending macro-fractures. These lineaments have been interpreted to be indicative of a zone of significant basement faulting, possibly associated with the Bracket Fault shown on photogeologic studies (Geophoto Services, Ltd., 1963). Several of the fracture density trend axes appear to terminate in this zone, including the trend axis through Anomaly "C" and trend axes drawn through high fracture density patterns to the west of Anomaly "C".

A north trending, high fracture density pattern is located immediately west of Anomaly "C_2". This high fracture density pattern coincides with a zone of exposed bedrock as shown on the photogeologic evaluation of this area (Geophoto Services, Ltd., 1963). A higher incidence of macro-fracture density is generally found over exposed bedrock than over areas mantled by glacial drift, which probably accounts for the high fracture density in the vicinity of this bedrock feature.

<u>Anomaly "D"</u> - Anomaly "D" has been designated in three

areas to the west. The northeast trending axis from Anomaly "C_2" may then indicate cross-structural features related to earlier Paleozoic tectonics and the junction of these two axes may be the locus of a subsurface positive feature. The southeast part of Anomaly "C_2" appears to be bounded by a series of northeasterly trending macro-fractures. These lineaments have been interpreted to be indicative of a zone of significant basement faulting, possibly associated with the Bracket Fault shown on photogeologic studies (Geophoto Services, Ltd., 1963). Several of the fracture density trend axes appear to terminate in this zone, including the trend axis through Anomaly "C" and trend axes drawn through high fracture density patterns to the west of Anomaly "C".

A north trending, high fracture density pattern is located immediately west of Anomaly "C_2". This high fracture density pattern coincides with a zone of exposed bedrock as shown on the photogeologic evaluation of this area (Geophoto Services, Ltd., 1963). A higher incidence of macro-fracture density is generally found over exposed bedrock than over areas mantled by glacial drift, which probably accounts for the high fracture density in the vicinity of this bedrock feature.

<u>Anomaly "D"</u> - Anomaly "D" has been designated in three

parts in order to facilitate the description of the anomaly. Perhaps the most significant part of Anomaly "D" is located at "D_1", where a low and intermediate fracture density pattern is surrounded on three sides by high fracture density patterns. Anomaly "D_1" is located on the south side of the zone of significant faulting described above. It is also located to the north of a second zone of lineation which is interpreted to be indicative of significant subsurface faulting. The two zones of lineation may outline a basement horst or graben. The northeast trend of these lineaments is nearly perpendicular to the Franklin Mountain Front and thus may indicate a period of older tectonics than that which formed the adjacent mountains. Therefore, these fault zones have been interpreted to indicate faulting or zones of weakness possibly extending to the Precambrian basement. The off-set in fracture density trends in the vicinity of Anomalies "D_1" and "D_2" may indicate transcurrent faulting with right lateral movement. "D_1" may be further separated from "D_2" by a very distinct macro-fracture trending N45°W.

Anomaly "D_3" is located on the north side of Sheet 2, where the low fracture density trend is surrounded on the southeast side by very high fracture density patterns. A significant subsurface change may occur along this high fracture density pattern. The general trend of this high fracture density pattern may indicate a subsurface ridge or depression trending east-northeasterly and separating lithologic types to the north and south of this trend. If this high fracture density pattern indicates a subsurface high then paleotopography may have been developed on the basin side of the feature, with small embayments and headlands represented by the fracture density pattern. As little subsurface information is available, it is difficult to ascertain the true significance of this anomalous trend. In any case, Anomaly "D_3" and Anomaly "D_2" to the northeast, may be significant.

Anomaly "E" - Anomaly "E" is composed of a low and intermediate fracture density zone generally trending northeasterly. This anomaly appears to be bounded on the northeast by a very distinct macro-fracture trending N55°W. The anomaly is surrounded by low fracture density patterns. If the effects of glacial grooving and small lakes were removed from the vicinity of this anomaly, the anomaly would probably be a high fracture density zone, in which case, it may be representative of a subsurface high on which differential compaction of overlying sediments has occurred along the flanks and crest. On the other hand, the anomaly may represent a subsurface low surrounded by structural high areas here represented as low fracture density zones. Subsurface lows of this pattern may be formed by salt solution. The geomorphic study shows this area to be one of considerable significance.

Anomaly "F" - Anomaly "F" is generally described as a low and intermediate fracture density pattern trending northerly. Anomaly "F_1", located at the north end of the trend axis, is composed of low and intermediate fracture density patterns surrounded by zones of high fracture density. It appears to be bounded on the southeast by a very distinct macro-fracture trending N50°E ; however, the trend axis continues southward to Anomaly "F_2". This trend axis is subparallel to a series of trends which have been shown in conjunction with Anomaly "J" on the east side of the map sheet. A small bifercation of the northerly trend occurs in the vicinity of White Losh Lake, where a trend appears to be developing subparallel to the very distinct N50°E trending macro-fracture.

Anomaly "F_2", located at the south end of the trend axis is partially surrounded by high fracture density zones. Most of the anomaly is bounded on the west by a zone of very high fracture density which may reflect an area of intense faulting or weaknesses in the Precambrian basement. A very low fracture density pattern is located around Lost Hill Lake, northeast of Anomaly "F_2". This low fracture density pattern probably reflects the presence of Lost Hill Lake and other lakes and glacial grooves within the area. Anomaly "F" may continue southward and join with Anomaly "I". Anomaly "F", extending from "F_1" to "F_2", may be indicative of a subsurface positive feature or a zone of competent lithology which changes in competency towards the west. The high fracture density zone on the west and the postulated high fracture density zone immediately east of Anomaly "F", may then reflect differential compaction over a subsurface high or differential compaction over beds of differing competency.

Anomaly "G" - Anomaly "G" is a low fracture density zone believed to trend southeasterly. It is very large in aerial extent and a secondary trend may extend southwesterly through Anomaly "H_1". The anomaly may be bounded on the north by a very distinct macro-fracture trending N35°E and a distinct macro-fracture bearing N65°W. The northeast trending macro-fracture may be part of a zone of significant subsurface faulting. The northwest part of the anomaly is generally surrounded by a high fracture density pattern. Anomaly "G" may continue northwestward towards Anomaly "E". If such is the case, the most significant part of this anomaly may be located on a saddle between the two high density zones northwest of "G". The very extensive glacial grooving and numerous small lakes probably obscure many air photo lineaments ; thus tending to create a low fracture density zone and making an interpretation most difficult. The trend axis through Anomaly "G" may join with an axis drawn through Anomaly "I" on the northeast.

Anomaly "H" - Anomaly "H" is a low fracture density zone subparallel to anomalies "D_2" and "D_3" and the Franklin Mountain Front. This anomaly is generally bounded on the east and west by zones of high fracture density. It may be bounded on the northeast by a very distinct macro-fracture trending N45°W. The very high fracture density zone on the east may indicate a sharp subsurface change in that direction.

Anomaly "H" has been subdivided into "H_1" and "H_2". "H_1" may be part of a northeasterly trend which continues northeastward through Anomalies "G" and "I". Anomaly "H_2" is generally surrounded on three sides by high fracture density possibly indicating a subsurface feature of considerable relief. The high fracture density pattern on the south is transverse to the regional fracture density trends. As previously mentioned, it may indicate paleotopography or paleoshorelines along which embayments and headlands have been developed. Anomaly "H_2" may be a manifestation of one of these possible paleotopographic features in which case a change in lithology may be indicated.

Anomaly "I" - Anomaly "I" appears to be a small isolated feature composed of low and intermediate fracture density zones, trending northeasterly. The anomaly may be bounded on the southeast by a very distinct macro-fracture trending N25°E. It may also be bounded on the southeast by a very distinct macro-fracture trending N65°W. The low and intermediate fracture density trend axis through Anomaly "F" may join with Anomaly "I" in an area to the northwest of Anomaly "I". Anomaly "I" may be a northeasterly trending subsurface high surrounded by high fracture density which is reflecting differential compaction on the margins of this feature.

Anomaly "J" - Anomaly "J" consists of a group of intermediate and low fracture density patterns which generally trend northerly and are located between zones of high fracture density. Anomaly "J_1" on the north is generally surrounded by high fracture density patterns. The low incidence of lineaments here may be due to Tuitatui Lake which may have obscured many fractures in this area. A similar relationship may have occurred in the vicinity of Anomaly "J_2" where Lost Hill Lake and Kekwinatui and Man Drowned Himself Lakes may have obscured many macro-fractures. In view of the relationship with the high fracture density trends on either side of Anomaly "J", it is believed that, in general, this area would have a low incidence of lineaments regardless of the position of the lakes. Anomaly "J_3" may be separated from "J_1" and "J_2" by a zone of high fracture density. Anomaly "J3" is surrounded by high fracture density patterns and may indicate the presence of an isolated subsurface positive feature. Anomaly "J4" is also generally surrounded by high fracture density patterns. A very high fracture density pattern occurs to the east of this anomaly. "J4" may be separated from Anomaly "I" to the west, by a very distinct macro-fracture trending N25°E and a high fracture density pattern. This anomaly could also be terminated on the south by a distinct macro-fracture trending N65°W. Anomaly "J" may represent a long subsurface positive feature extending in a north-south direction or it may indicate four separate, isolated subsurface highs particularly well developed or perhaps with greatest relief at Anomalies "J3" and "J4".

Anomalies "J", "F", and possibly "I", are northerly trending, subparallel, and separated by zones of high density. This relationship may indicate north trending subsurface features as further shown by Anomalies "6" to "9" on the Geomorphic Analysis Maps.

Sheet 2

<u>Anomaly "K"</u> - Anomaly "K" is composed of three groups of

very high fracture density. This zone of very high fracture density is believed to indicate a zone of significant subsurface change. This change may be tectonic, structural or lithologic. An abrupt change in outcrop pattern, as shown by a previous photogeologic study (Geo-photo Services, Ltd., 1963) suggests a possible change in structural grain in the mountains west of this anomaly. However, very few well defined macro-fractures appear to parallel this trend. A number of fracture density patterns terminate against this high fracture density zone. Anomalies "D_3" and "H_2", on the north, terminate on the north side of the anomaly, and low fracture density patterns "L", "M", and "N", may terminate against a subsurface feature in the vicinity of "K". Nearly perpendicular high fracture density trends intersect the principal trend from the northwest at "K_1" and "K_2". The high fracture density trend discussed in association with Anomaly "J" on Sheet 1, may also continue southward and join with this broad high fracture density zone in the vicinity of Anomalies "K_2" and "K_3". A very distinct macro-fracture trending N70°W crosses the anomaly at an acute angle to the anomaly and glacial grooving. One short, very distinct macro-fracture, trends N65°E on the west side of Anomaly "K_1". This anomaly also appears on the Geomorphic Analysis Map.

The high fracture density may indicate a subsurface high.

This postulated high may be a northeast trending anticline, barrier reef, or basement horst.

Anomaly "L" - Anomaly "L" is an intermediate fracture density pattern generally trending southwesterly, nearly perpendicular to the mountain front. It is on trend with a possible tear fault along Big Smith Creek. The north part of this anomaly is surrounded by very high fracture density patterns associated with Anomaly "K_1". It is bounded on the south by high fracture density described as "O". The outcrop pattern of the Hume, Bear Rock and Ronning Formations is suggestive of anomalous geologic conditions in this area. A major basement fault, bearing N65°E may be present in the high fracture density pattern northwest of "L" and continuing southwest through the offset in the outcrop pattern to the west, and through Old Fort Point on the Mackenzie River. The Mackenzie River is sharply deflected at Old Fort Point. The broad exposure of Hume, Bear Rock and Ronning sediments may indicate that the mountain front has been uplifted or forced eastward over a buttress in the basement surface. If this is the case, Anomaly "L" may indicate the extent of such a basement feature. Differential compaction at Anomalies "K" and "O" may explain the high fracture density pattern at those locations.

Anomaly "M" - Anomaly "M" is a long, northerly trending zone of low and intermediate fracture density, generally subparallel to the Franklin Mountain Front.

Anomaly "M_1", the northernmost part of the anomaly, is generally surrounded by high fracture density much of which is associated with Anomaly "K". Important faulting may have taken place in the vicinity of Anomaly "M_1" where two westerly trending macro-fractures have been offset in a left lateral manner along a northwesterly trending macro-fracture. Anomaly "M_1" may indicate the presence of a subsurface high zone extending either northeasterly or northwesterly. If it is a northwesterly trending zone, it may join with Anomaly "H_2" on the adjoining sheet.

Anomaly "M_2" is located to the north of a very distinct macro-fracture trending N55°E which may be a continuation of a north-east trending fault located south of Little Smith Creek. Anomaly "M_2" is generally defined as a north-northeasterly trending feature; however, it may extend somewhat more easterly along the very distinct macro-fracture trending N55°E.

Anomaly "M_3" is located in an area of slight widening in the overall low and intermediate fracture density pattern. Anomalies "M_3" and "M_4" form a northwesterly trend. Anomaly "M_3" is located between a very high fracture density zone on the northeast and a zone of complex structure in the exposed bedrock southeast of Mount Clark. Anomaly "M_3" may indicate a rather broad basement high. Anomaly "M" is believed to continue southeastward, generally parallel to the mountain front. The general fracture density trend becomes constricted in the vicinity of Anomaly "M_4" which may lie to the south of a very distinct macro-fracture extending N50°E and delineated as terminating northeast of "M_4". This macro-fracture may represent a most significant, right lateral, transcurrent basement fault. The overall trend of Anomaly "M" may become east-west through Anomaly "M_4". "M_4" may also join Anomaly "S" on the northwest. However, it is believed that Anomaly "M" is separated from "S" by a very distinct macro-fracture trending N30°E. Anomaly "M" may represent subsurface folding parallel to the mountains which may have occurred at the time of principal mountain building to the west. Local constrictions and broadening in the pattern of low fracture density on this trend may represent older Paleozoic features.

Anomaly "N" - Anomaly "N" is a low and intermediate fracture density pattern bounded on the north, east, and west by high fracture density. It is further bounded on the southwest and southeast by very distinct macro-fractures trending N70°W and N55°E respectively.

The anomaly is located on the north end of an intermediate fracture density zone which trends southeasterly. The high fracture density zone to the north has been described as Anomaly "K" and discussed in previous paragraphs. Anomalies adjacent to this high fracture density zone may be very significant features in the subsurface and worthy of additional exploration. Anomalies "L", "N", and "M", have an appearance similar to that of "D" and "H" on Sheet 1. If Anomaly "K" is representative of paleotopography, "L", "M" and "N" may be headlands or embayments. If Anomaly "K" represents a depression in the subsurface, then Anomaly "N" may be part of a high or ridge extending northward across Anomaly "K". Anomalies "N", "Q", "T" and "X" are all located in a broad area of low and intermediate fracture density. The low fracture incidence in this area may be due to glacial grooves, lakes, and ice disintegration features. Zones of intermediate density should probably be interpreted as high fracture density with respect to surrounding areas on the map sheet.

Anomaly "O" - Anomaly "O" is a high fracture density pattern generally parallel to the mountain front and extending northerly across the map sheet. Anomaly "O" intersects Anomaly "K" near "K_1". The anomaly may continue southward, crossing the north side of Anomaly "S", to join with Anomaly "W". The proximity and parallelism of this anomaly with the mountain front may indicate the subsurface presence of a feature related to the mountain building processes. Anomaly "O" may be bounded on the north by a fault extending N35°E and macro-fractures trending N85°W or N25°W.

<u>Anomaly "P"</u> - Anomaly "P" consists of a high fracture density pattern subparallel with Anomalies "M" and "O" and the Franklin Mountain front. "P_1" is located on the north portion of the trend and may be bounded on the north by a very distinct macro-fracture trending N55°E. It may be bounded on the east by a very distinct macro-fracture trending N20°W. Distinct macro-fractures trending N25°W are located to the west side of "P_1". Anomaly "P_1" may be part of a large feature extending parallel to the mountain front or it may be an isolated feature over which differential compaction has occurred. The relative incidence of fracture density in the vicinity of "P_1" indicates that if this is an isolated feature, the greatest relief should occur on the southeast side where the fracture density is somewhat higher than around the rest of the anomaly.

Anomaly "P_2" is bounded on the southeast by very distinct macro-fracture trending N30°E and probably bounded on the north by a very distinct macro-fracture trending N50°E. This north bounding north side of Anomaly "S", to join with Anomaly "W". The proximity and parallelism of this anomaly with the mountain front may indicate the subsurface presence of a feature related to the mountain building processes. Anomaly "O" may be bounded on the north by a fault extending N35°E and macro-fractures trending N85°W or N25°W.

<u>Anomaly "P"</u> - Anomaly "P" consists of a high fracture density pattern subparallel with Anomalies "M" and "O" and the Franklin Mountain front. "P_1" is located on the north portion of the trend and may be bounded on the north by a very distinct macro-fracture trending N55°E. It may be bounded on the east by a very distinct macro-fracture trending N20°W. Distinct macro-fractures trending N25°W are located to the west side of "P_1". Anomaly "P_1" may be part of a large feature extending parallel to the mountain front or it may be an isolated feature over which differential compaction has occurred. The relative incidence of fracture density in the vicinity of "P_1" indicates that if this is an isolated feature, the greatest relief should occur on the southeast side where the fracture density is somewhat higher than around the rest of the anomaly.

Anomaly "P_2" is bounded on the southeast by very distinct macro-fracture trending N30°E and probably bounded on the north by a very distinct macro-fracture trending N50°E. This north bounding macro-fracture is believed to be a very significant feature in this study. It is found to be in line with a northeast trending fault shown on the photogeologic study (Geophoto Services, Ltd., 1963); linear courses of the Dahadinni River, and Redstone River in the Mackenzie Basin. It is further shown on the photogeologic evaluation that a number of synclines and anticlines and other major structural features appear to terminate against this postulated fault zone. Regional maps (Geological Survey of Canada, 1963) show that this zone is nearly coincident with the McVicar Arm of Great Bear Lake and other linear features to the north along the lake, thus suggesting that this macro-fracture may be a fault which could be traced onto the Canadian Shield. Due to the offset and termination of lineaments and other features along this zone, including axes shown on the photogeologic evaluation, right lateral movement has been postulated. Therefore, this lineament may be a significant feature not only in the area of the present study but also in the Mackenzie Basin. The fact that the lineament does not extend completely across the map sheet may indicate that recent movement has occurred only along limited portions of this regional feature. Anomaly "P_2" located immediately south of this very distinct macro-fracture, is composed of very high fracture density which may indicate the presence of intersecting fault trends, differential compaction over a basement or subsurface feature, or differential compaction due to salt collapse. Anomaly "P_2" may join with Anomaly "W" to the southwest and may represent a sub-surface high over which the Franklin Mountains have been forced revealing an outcrop pattern somewhat east and slightly offset from the regional mountain trend.

Anomaly "P" can also be interpreted to be a reflection of a subsurface feature paralleling the mountain front. This feature could be a barrier reef, or off-shore bar. Then "M", "Q", and "U" may represent areas of important facies change. It also may represent differential compaction over an anticline or syncline.

Anomaly "Q" - Anomaly "Q" is a northeast trending, low and intermediate fracture density pattern. This anomaly is bounded on the west and south by intermediate and high fracture density zones. The anomaly appears to be bounded on the east by a very distinct macro-fracture trending N20°W. Anomaly "Q" extends northeastward into a zone of very extensive glacial grooving and small lakes. Anomaly "Q" may be an isolated subsurface high plunging northeastward and having an abrupt termination in the zone of high fracture density where differ-ential compaction may have occurred.

Anomaly "R" - Anomaly "R" is an intermediate fracture density pattern trending northeasterly. It is bounded on the west by Little Smith Fault shown on the photogeologic study (Geophoto Services, Ltd., 1963) and on the east by a zone of high fracture density designated as Anomaly "O". Anomaly "R" may be limited to the north and south by faults extending eastward from the mountains. These faults in the vicinity of Big Smith and Little Smith Creeks, are wrench faults along which displacement has occurred. Anomaly "R" is generally suggestive of a subsurface high. Faults in the mountain front and the overall outcrop pattern suggest that the movement of beds may have been interrupted by a subsurface obstacle such as a northeast trending basement ridge. Dips along the front in this area are very steep and the outcrop pattern is somewhat west of the regional trend indicating that it has not been able to advance eastward in this local area. The overall breadth of outcrop is wider on the west side of Anomaly "R". Therefore, Anomaly "R" may be a northeast trending subsurface high or early Paleozoic or Precambrian age.

Anomaly "S" - Anomaly "S" is an intermediate fracture density pattern trending northeasterly and is bounded on the north by a high fracture density pattern and on the south and west by the Franklin Mountains. Anomaly "S" may represent a feature similar to that of Anomaly "R". The relationship of the anomaly to the mountain front is very similar to that of "R", as it is located immediately east of a zone of significant wrench faulting and an offsetting of the mountain front. Vertical to overturned bedding is prominent in the strata to the west. Therefore, Anomaly "S" is interpreted to represent a high lineament density pattern of early -Paleozoic or Precambrian age.

Anomaly "T" - Anomaly "T" is an intermediate fracture density pattern trending northwesterly. It is surrounded by a zone of low fracture density and in view of the extensive glacial grooving and numerous lakes present in the vicinity of this anomaly, may actually represent a bedrock high lineament pattern. Anomaly "T" is crossed by very distinct macro-fractures trending N30°E and N 50°E. The lineament trending N50°E has been interpreted to be a significant basement fault. Anomaly "T", along with Anomalies "N", "Q" and "X", are located in a broad area of low fracture density, which may reflect terrain conditions. If, on the other hand, this low fracture density is representative of fractures in the bedrock, then the overall pattern of this low fracture density area may indicate a large subsurface positive feature. A northwesterly trending sub-surface low may exist here and have localized glaciation at this location.

Anomaly "U" - Anomaly "U" is a westerly trending intermediate to low fracture density pattern which may join with Anomaly "M_4" to the west. A low fracture density pattern continues southwesterly from the designated anomaly but the low fracture incidence in this area is probably related to "fall-off effect" of Blackwater Lake. The anomaly is bounded on the east and northwest by zones of high fracture density. Therefore this anomaly may indicate an east plunging feature over which differential compaction has occurred on the east, north, and south. Anomaly "U" may be separated from "M_4" by a very distinct macro-fracture trending N30°E. Anomaly "U" may be a small headland or embayment controlled by features associated with "P". Therefore, "U" may be a logical location to expect significant facies change.

Anomaly "V" - Anomaly "V" is generally a rectangular shaped high fracture density pattern. It may be located on high fracture density trends which extend northerly, and northwesterly to join with Anomaly "P". These trends appear to intersect in the vicinity of Anomaly "V". The overall pattern is generally surrounded by low and intermediate fracture density. Anomaly "V" may represent an isolated subsurface high, or if evaporites are present in the subsurface, this pattern could represent a solution cavity. "V" may also join Anomaly

"U" indicating a northwesterly trending feature with sharp relief on the south end.

Anomaly "W" - Anomaly "W" is a very high fracture density pattern adjacent to the mountain front. It is the only very high fracture density pattern which extends to the mountains. The anomaly is bounded on the south by a very distinct macro-fracture trending N30°E and may be bounded on the north by the interpreted significant basement fault trending N50°E which has been correlated with a wrench fault in the mountains. The mountain front adjacent to this anomaly, appears to be offset eastward perhaps indicating the presence of a depression on the early Paleozoic or Precambrian basement surface which has allowed the mountain front to be pushed somewhat further east than either to the north or to the south of the anomaly. Another possible explanation for Anomaly "W" may be that it is a zone of intense subsurface faulting related to the mountain building processes and intersected by older Paleozoic faulting along which reactivation may have occurred.

Anomaly "X" - This anomaly is of low and intermediate fracture density. The "halo" effect produced by the surrounding high fracture density pattern has often been found to be a very good indicator of subsurface draping. The intensity of glacial grooving southwest of the anomaly has undoubtedly obscured many valid fracture traces, thus resulting in the very low density pattern at that end of Anomaly "X". This anomaly may be bounded by subsurface faults bearing N55°W, N30°W, N50°E, and N25°E.

The overall fracture density pattern suggests an isolated subsurface high bounded by the lineaments listed above. Anomaly "X" may also be interpreted to be a feature in a subsurface low similar to Anomalies "N" and "Q". Therefore, it may be an embayment or headland and lithologic change may be important.

GEOMORPHIC ANALYSIS

General Remarks

The purpose of this geomorphic analysis was to ascertain structural and/or lithologic configuration of the subsurface through the selection and interpretation of various geomorphic criteria. The Geomorphic Analysis was conducted independently from the Macro-Fracture Analysis, and the data of the two studies brought together at the time of report writing. A geomorphic study, at a scale of one inch equals two miles, must be considered a reconnaissance evaluation. A more precise and probably more accurate geomorphic interpretation can be made by utilizing a stereoscopic study of aerial photographs at a scale of one inch equals one mile or greater. A very brief perusal of the individual air photographs was made in this study. Particular attention was paid to various features previously selected on the aerial mosaics and on the topographic maps.

Method of Analysis

The first stage in this geomorphic analysis was to color alternate topographic contours on the Federal Government 1:250,000 scale topographic maps. Coloring topographic maps facilitates the selection of topographic features such as: areas of anomalous topographic flattening, topographic offsets, linear topography, and anomalous drainage dissection. The second phase of the geomorphic analysis consisted of selecting tonal anomalies on air photo mosaics at a scale of one inch equals two miles. Many of the glacial features and various other phyiographic criteria, were annotated on these mosaics including: outwash channels, ancestrial drainage channels, glacial grooves, and strand lines or lake terraces. The third phase of the Geomorphic Analysis consisted of a detailed analysis of the drainage patterns present on the base map and on the mosaics. The base maps were constructed by Geophoto Services, Ltd., utilizing the 1:250,000 topographic maps. The fourth phase of this study consisted of combining all information on an overlay at a scale of one inch equals two miles. The most reliable, and apparently most significant data, were transferred to the base maps. The most significant data were deemed to be those geomorphic features which were supported by more than one type of anomalous condition or repetitive geomorphic pattern. The final stage of the geomorphic analysis consisted of drawing geomorphic trend axes to logically connect the various geomorphic anomalies and provide a best fitting, continuous trend to support any known regional geologic criteria. Several of the geomorphic axes were found to coincide with trends previously delineated on an exclusive photogeologic evaluation of the Franklin Mountains conducted for Sinclair Canada Oil Company.

Physiography

The maximum total relief in the Franklin area is approximately 1,300 feet. The highest point within the project area is located in the southeast corner of Sheet 2 where a small range of hills is slightly over 1,600 feet in elevation. A similar elevation is found to the west of Great Bear Lake and northeast of Fort Franklin where the hills (here termed the "Franklin Hills") attain an elevation of slightly over 1,600 feet. The lowest point within the area of this study is located on Great Bear River, where it exits the west project boundary on the southwest part of Sheet 1. At this location, the elevation of the river is approximately 300 feet. Other scattered hills within the project boundary range from 1,600 feet to approximately 1,200 feet in elevation. The average elevation of the lowlands ranges from 700 to 900 feet. The highest mountain in the adjacent Franklin Mountains is Mt. Clark, which has an elevation of 4,798 feet and is located just west of Sheet 2.

The most prominent physiographic feature located within the project boundary, is probably the Keith Arm of Great Bear Lake which is located on the southeast corner of Sheet 1. Byand Bay and Ford Bay which are parts of Smith Arm of Great Bear Lake, enter the project area along the north boundary. Other prominent lakes are Mahoney Lake, located on the west side of Sheet 1 and Blackwater Lake located on the south side of Sheet 2. Other smaller lakes, many of which are unnamed, are located within the project boundaries.

The north half of the Franklin area is drained by Whitefish River into Smith Arm and tributaries to Great Bear Lake, Mahoney Lake and Great Bear River, which flows westward into the Mackenzie River. The northwest part of Sheet 2 is drained by St. Charles Creek which flows into Great Bear River. The northeast part of Sheet 2 is drained by Porcupine River and Clements Creek which both flow northward into the Great Bear River and Great Bear Lake respectively. The southeast part of the Franklin area is drained by Johnny Ho River which beyond the project boundary, flows northeastward into Great Bear Lake. The southern part of the project generally drains into Blackwater Lake.

Geomorphic Criteria

The following geomorphic conditions were studied and delineated, when present, in arriving at an interpretation of the geomorphology of this area.

1. Topography
   a. topographic flattening
   b. topographic form lines
   c. topographic offset
2. Drainage
   a. arcuate drainage
   b. annular drainage
   c. barbed drainage
   d. radial drainage
   e. deflected drainage
   f. constricted drainage
   g. meander pattern
   h. restricted drainage
   i. ancestral drainage (including preglacial and outwash channels).
   j. asymmetric drainage
   k. stream piracy and elbow of capture

l. stream terraces and strand lines

m. dissection patterns

3. Tonal Patterns - the relationship of tonal patterns is questionable in the Franklin area, due to the log-e-tronic printing of Panchromatic photographs. This type of printing involves tone-matching of adjacent flight lines in order to reduce the tonal difference in adjoining flights. The method is very satisfactory for producing photographs to be utilized in fracture analysis; however, it tends to subdue the overall tonal patterns which may have geomorphic significance. On the other hand, this type of printing may enhance the value of those tonal anomalies which are still found in the Franklin area.

4. Drainage Divides - selected drainage divides have been placed on the Geomorphic Analysis Maps where they are thought to add reliability to the interpretation.

5. Textural change in groove pattern - Where glacial grooves are well defined and continuous over considerable distance but have an interruption along their course in a linear or curvi-linear manner, this inter-

l. stream terraces and strand lines

m. dissection patterns

3. Tonal Patterns - the relationship of tonal patterns is questionable in the Franklin area, due to the log-etronic printing of Panchromatic photographs. This type of printing involves tone-matching of adjacent flight lines in order to reduce the tonal difference in adjoining flights. The method is very satisfactory for producing photographs to be utilized in fracture analysis; however, it tends to subdue the overall tonal patterns which may have geomorphic significance. On the other hand, this type of printing may enhance the value of those tonal anomalies which are still found in the Franklin area.

4. Drainage Divides - selected drainage divides have been placed on the Geomorphic Analysis Maps where they are thought to add reliability to the interpretation.

5. Textural change in groove pattern - Where glacial grooves are well defined and continuous over considerable distance but have an interruption along their course in a linear or curvi-linear manner, this inter-

ruption may reflect a fault or lithologic change in bedrock.

Geomorphic Anomalies

The following anomalies have been delineated on the Geomorphic Analysis Maps. Those areas which are colored yellow on the final maps, are believed to be significant and may reflect subsurface features. Where a number is included within the yellow pattern, or adjacent to the pattern, they are described in the following paragraphs. The numerical value in no way indicates relative significance of the anomaly. In some cases, numbers have been placed on the map sheet in order to offer a means of locating a specific description of a geomorphic trend axis rather than an individual anomaly. It is believed that the most significant anomalies are those which contain the greater number of substantiating criteria. It is further believed that where these significant anomalies are supported by anomalous conditions on the Macro-Fracture Analysis Maps, they are of greatest significance. A correlation of geomorphic and macro-fracture anomalies and studies will be made at the end of this report.

Many more geomorphic criteria have been originally delineated than are shown on the final map. In order to maintain clarity many criteria have had to be omitted where they failed to meet standards of anomalous designation.

Sheet 1

Anomaly "1" - Anomaly "1" is located in the northwest part of Sheet 1 and is defined by a elliptical shaped tonal pattern and arcuate drainage. The anomaly is located to the east of a very prominent zone of tonal patterns which extends beyond the project boundary. A previous photogeologic evaluation (Geophoto Services, Ltd., 1963) has shown anticlines and synclines extending west-southwesterly from the area of this anomaly. However, the overall shape of "1a" and "1b" appears to indicate that a north trending feature may be present, subparallel to the Franklin Mountains, through this area.

In the extreme northwestern corner of the project boundary and beyond, a number of significant geomorphic criteria were noticed on the topographic maps and individual aerial photographs. These geomorphic features included: a strong southward deflection of Indian River as it flows westward from Smith Arm, northerly deflection of other streams to the north-northeast of Indian River and the possibility of tension fractures in glacial drift extending over a local topographic high. Stereoscopic coverage of these features was not available. However, there was strong evidence on one photograph (No. 12 609-289) to indicate eastward bedrock dip along the course of the Indian River before it is deflected southward. If a feature is present across Indian River and northeastward, it would be subparallel to Anomaly "1". It may also bear relationship to the strong tonal patterns present on the northwest side of Sheet 1. This feature is interpreted to be a dome or anticline.

Anomaly "2" - An abrupt change in the glacial groove pattern is located east of Anomaly "1". The tonal pattern developed there is spheroidal in shape and appears to trend north-northeasterly. A portion of this tonal pattern contains a zone of anomalous topographic flattening. Glacial grooving through this anomaly is very intense and this interruption in the glacial groove pattern may indicate a subsurface or bedrock high which has interrupted the glacial groove pattern. A small isolated tonal pattern and topographic high lies immediately northeast of Anomaly "2".

Anomaly "3" - Anomaly "3" consists of a number of arcuate and annular drainage patterns and sharp tonal patterns. A geomorphic trend axis has been drawn northwestward to connect Anomalies "3a" and "3b". Anomaly "3a" consists of strong isolated tonal patterns and a small arcuate drainage pattern not shown on the base map, but quite prominent on the mosaic. An isolated tonal pattern and annular drainage patterns are located between "3a" and "3b". Anomaly "3b" is exceptionally well shown on the aerial photographs. It consists of concentric tonal patterns, arcuate lakes and annular stream courses. The geomorphic trend axis through Anomaly "3" is subparallel to the Franklin Mountain front and features to the east. The trend axis through "3" may terminate against a very distinct macro-fracture near fracture Anomaly "C".

Anomaly "4" - This elongate anomaly is described by a tonal pattern and arcuate drainage. A sharp offset in Whitefish River is found to nearly coincide with the outline of the tonal pattern and is located immediately east of Anomaly "4". A geomorphic trend axis has been drawn through Anomaly "4", northwestward to include stream deflections in that direction. Anomaly "4" may be a north trending anticline. It is also partially coincident with a low fracture density trend axis.

Anomaly "5" - Anomaly "5" is located in the north-central part of Map Sheet 1, and consists of arcuate and annular drainage patterns. A geomorphic axis has been drawn north-northeastward through Anomaly "5" connecting tonal and arcuate stream and lake patterns. This axis may join with an axis through Anomaly "6" and continue northward across a narrow part of Smith Arm into an area of anomalous high topography. This axis may be subparallel with the axis discussed in Anomaly "1" and the possible anticline or dome extending through the northwest corner of the map sheet.

Anomaly "6" - The large area encompassed by Whitefish River and containing White Water Lily Lake may represent an extremely significant subsurface feature. It will be noted that Whitefish River and several of its tributaries are very arcuate around a broad topographic rise. The lake patterns associated with this large feature are generally bounded on the north and south by arcuate patterns as though there was a nosing towards the south. A geomorphic trend axis has been drawn from "6a" to "6c". At "6a" a small tonal pattern is further outlined by annular or arcuate drainage patterns. A prominent tonal pattern is present on the geomorphic axis and designated as Anomaly "6b". Southward from "6b" and just north of Whitefish River, is located a very sinuous tonal pattern, quite apparent and readily observed on the mosaic covering Sheet 1. Continuing southward across Whitefish River, another small tonal pattern is crossed by the geomorphic trend axis and "6c" is encountered northwest of Fort Franklin. Anomaly "6c" is well defined by arcuate drainage on the base map and smaller drainage patterns as shown on the mosaic. These latter drainage patterns are probably developed in outwash sands and gravels. Another minor axis which has been drawn solely on the presence of tonal patterns and the sharp deflection in Whitefish River, has been drawn between Anomalies "3" and "6". To the west of this intermediate axis is located a significant change in the habit of Whitefish River, where it appears to be strongly constricted within its channel with little meandering. Anomaly "6" and the features to the west, may be a part of a larger anticlinirium or synclinorium of closely spaced subsurface highs and lows trending northerly. The southern part of the Anomaly "6" trend axis may join a high fracture density trend.

Anomaly "7" - A geomorphic anomaly and trend axis has been delineated immediately east of Anomaly "6", where extremely sharp deflections in Whitefish River and its tributaries has occurred. The axis through Anomaly "7" is generally parallel to the axis through Anomaly "6" and may indicate a parallel subsurface anticline or syncline.

Anomaly "8" - Anomaly "8" is located northeast of Anomaly "7" and is outlined by sharply arcuate drainage patterns and lake development. A geomorphic trend axis parallel to those designated through Anomalies "6" and "7", continues southward across a constricted reach of Whitefish River and through an arcuate portion of one of its tributaries.

Anomaly "9" - A strong tonal pattern, with broadly arcuate drainage surrounding it has been delineated straight east of Anomaly "7" and is designated "9a". A geomorphic trend axis has been drawn northwesterly parallel to the axes through Anomalies "6", "7" and "8". An area of anomalous topographic flattening is located between Anomaly "9a" and "9b". Anomaly "9b" is composed of arcuate minor streams shown on the mosaic but not present on the base map, and a circular tonal pattern. On the south end of the geomorphic trend axis is located a very arcuate stream course indicating that this trend may continue across Keith Arm, to the south shore, where it may join with another geomorphic trend.

Anomaly "10" - The geomorphic axis through Anomaly "10" has also been drawn in a northerly direction. Arcuate stream patterns and a northeast elongated zone of topographic flattening, located immediately southwest of "10a", may indicate that the geomorphic axis in this area should trend northeasterly. However, there appears to be a random orientation of geomorphic anomaly configurations in the north-east part of map Sheet 1. Anomaly "10a" is composed of arcuate stream courses and a topographic low, it is also coincident with Anomaly

"F". The area designated as "10b" is composed of concentric tonal patterns and is partially coincident with a very large area of topographic flattening. This area of topographic flattening is surrounded by White Losh Lake, Tuitatui Lake, Man Drowned Himself Lake, and Lost Hill Lake. Smaller arcuate stream courses and tonal patterns are located within this broad area of topographic flattening. The overall trend of Anomaly "10" is subparallel to a low fracture density trend through Anomaly "F".

Anomaly "11" - A very elongate group of tonal patterns is found southeast of Tatui Lake. A group of northwest trending tonal lineations are found on the northeast side of Anomaly "11". These tonal patterns were viewed on the stereo photographs and found to not have any significant relief. They appear to be primarily zones of different types of vegetation. Such changes in vegetation are usually thought to indicate areas of differing water table conditions. Where vegetal changes occur along linear zones, such as occurred here, they are often construed to be indicative of subsurface faults. The lineaments in this case, may reflect bedrock slumping prior to glaciation, possibly followed by a time of planation and later glacial mantling. If on the other hand, these linear features are reflections of subsurface faults Anomaly "11" may be a very significant subsurface feature with an asymetric profile, steepening toward the east. The axis here is nearly perpendicular to the fracture trend.

Anomaly "12" - Anomaly "12" is composed of two isolated features which are best expressed on the mosaic. The northwest part has a very strong drainage and lake deflection pattern. The southeast part consists of a topographic low surrounded by arcuate stream courses. Small randomly oriented isolated features such as these have been found elsewhere to overlie pinnacle reefs.

Anomaly "13" - Anomaly "13" is a very good geomorphic anomaly which appears to trend northeasterly. It is generally defined by a zone of topographic flattening, which is partially surrounded by arcuate courses and the arcuate pattern of Man Drowned Himself Lake. The center of the anomaly contains a radial drainage pattern which is located at low fracture density Anomaly "J_2".

Anomalies "12" and "13" are quite well expressed and contain many of the essentials of a good geomorphic anomaly. There are several other similar patterns located in the vicinity of Anomaly "13", all of which appear to be randomly oriented. In view of the large very striking pattern of Whitefish River, and the enclosed patterns within the radius of Whitefish River, discussed in association with Anomaly "6", it appears that Anomalies "12" and "13" and other isolated non-oriented features to the east of the Whitefish drainage, may be significant. If Whitefish River is surrounding a subsurface high of Devonian age, then perhaps the small isolated features without apparent trend may indicate possible reefing conditions. It should be further pointed out that the Scented Grass Hills area located northeast of Tatui Lake, appear on the topographic maps to be very anomalous. The topographic outline of these hills is very angular indicating possible fault control. Therefore, the northeast part of the project area may be worthy of additional geologic investigation.

Anomaly "14" - Anomaly "14" is located near the southeast end of Mahoney Lake. This small, northeasterly trending geomorphic feature is defined by arcuate drainage. Its significance probably lies in its parallelism with the photogeologic anticline as shown on the previous photogeologic evaluation (Geophoto Services, Ltd., 1963). In view of the relationship and proximity to the mountain front and the anticline, this anomaly is probably a subsurface low. A subparallel trend to the east may be another anticline.

Anomaly "15" - A geomorphic axis has been drawn through Anomaly "15a" subparallel to Anomaly "14". Anomaly "15a" is defined by arcuate stream courses which are best shown on the photo mosaics. The northeast trending axis may be anticlinal in view of its proximity and relationship to Anomaly "14" and the photo-geologic anticline. Anomalies "14" and "15a" are located on the north side of the Bracket Fault projection. It has been found in the Macro-Fracture Analysis, that a zone of significant lineation occurs perpendicular to the mountain front and subparallel with the Bracket Fault trend through this area. If right lateral movement has occurred on this postulated fault zone, Anomaly "15a" may then represent a small isolated drag fold. A second axis has been drawn through Anomaly "15a" and it extends southeastward, subparallel to the mountain front.

Anomaly "15b" is outlined by an area of arcuate drainage patterns and low topography. Anomaly "15c" is designated by a zone of anomalous topographic flattening and a sharp deflection in the Great Bear River. This axis continues southward into Sheet 2, where it may join with a very long axis which has been interpreted to be anticlinal and is discussed in the following paragraphs under Anomaly "25".

Anomaly "16" - Anomaly "16" is mentioned in order to point out a long synclinal axis extending along the mountain front. This synclinal axis is defined by a number of arcuate and annular stream patterns and it crosses a zone of anomalous topographic flattening, immediately south of Anomaly "16". The synclinal interpretation is based mainly on the presence of an anticlinal axis to the east, which in turn is interpreted as being a continuation of a photogeologic anticline continuing north from Lat 64°46'N. The position of the anticlinal axis is controlled by prominent stream deflections and the Charles Rapids on the Great Bear River. The syncline of Anomaly "16" is also bordered on the west, at approximately Lat 64° 52'N, by a geomorphic anticline which is drawn as a continuation of a photogeologic anticline, mainly on the basis of tonal patterns.

Anomaly "17" - Anomaly "17" continues from Sheet 1 onto the center of Sheet 2. It is, in general, a long geomorphic axis whose position has been determined by a number of arcuate stream patterns and tonal anomalies. Anomaly "17a" is an elliptical area of annular drainage. This axis may be synclinal if the pattern established to the west is carried eastward through Anomaly "15". Anomaly "17b" is delineated by a sharp stream deflection and annular drainage, in addition to a tonal pattern. Other arcuate drainage patterns are located between "17b" and "17c". Anomaly "17c" is also delineated by an arcuate drainage pattern. The geomorphic axes through "15" and "17a" appear to be closely associated with a low fracture trend axis and Anomaly "D". Anomaly "17b" is coincident with Anomaly "L".

Anomaly "18" - Anomaly "18" continues from Sheet 1, into the center part of Sheet 2, and generally trends northwesterly. Anomaly "18a" is defined by an arcuate stream course and elliptical-shaped tonal pattern. If the tectonic pattern established near the mountains continues, this axis should be anticlinal. The outline of Anomaly "18a" indicates a subsurface high trending northwesterly.

East of "18a" is located another geomorphic axis based mainly on tonal patterns. The north part of this axis is also controlled by a zone of topographic flattening.

Anomaly "18b" is delineated by anomalous topography and circulartonal patterns. Arcuate drainage and tonal patterns to the south of "18b" control the position of the axis through Anomaly "18". Anomaly "18c", located in the northern part of Sheet 2, is defined by arcuate stream courses. It is also the location of an intersection of geomorphic trend axes. The overall northwesterly trend continues southeastward to "18d" and another axis extends eastward to Anomaly "23" and is controlled by arcuate streams. This axis is believed to be very significant and will be discussed with Anomaly "23". Anomaly "18d", near the center of Sheet 2, is delineated by a stream deflection and tonal pattern. In addition, it is partially controlled by the drainage divide. The northern part of the axis through Anomaly "18" is nearly coincident with a high fracture density trend axis. Part of Anomaly "O" is coincident with "18c".

the center part of Sheet 2, and generally trends northwesterly. Anomaly "18a" is defined by an arcuate stream course and elliptical-shaped tonal pattern. If the tectonic pattern established near the mountains continues, this axis should be anticlinal. The outline of Anomaly "18a" indicates a subsurface high trending northwesterly.

East of "18a" is located another geomorphic axis based mainly on tonal patterns. The north part of this axis is also controlled by a zone of topographic flattening.

Anomaly "18b" is delineated by anomalous topography and circular tonal patterns. Arcuate drainage and tonal patterns to the south of "18b" control the position of the axis through Anomaly "18". Anomaly "18c", located in the northern part of Sheet 2, is defined by arcuate stream courses. It is also the location of an intersection of geomorphic trend axes. The overall northwesterly trend continues southeastward to "18d" and another axis extends eastward to Anomaly "23" and is controlled by arcuate streams. This axis is believed to be very significant and will be discussed with Anomaly "23". Anomaly "18d", near the center of Sheet 2, is delineated by a stream deflection and tonal pattern. In addition, it is partially controlled by the drainage divide. The northern part of the axis through Anomaly "18" is nearly coincident with a high fracture density trend axis. Part of Anomaly "O" is coincident with "18c".

Anomaly "19" - Anomaly "19" is a fairly short geomorphic trend which is somewhat convergent with the axis drawn through "15", "17" and "18". Anomaly "19a" is delineated by strong annular drainage patterns on Stick Creek, and contains an area of low topography. This entire tributary to the Great Bear River appears anomalous and may result from stream piracy. The north portion of the axis through "19" is controlled by a tonal anomaly, arcuate and annular stream patterns and Anomaly "19b". Anomaly "19b" is outlined by a small tonal pattern, and very sharply deflected stream courses of Porcupine River and a tributary to the Porcupine River. A slight northeasterly trending axis may extend through Anomaly "21" from the vicinity of "19b". The geomorphic axis through Anomaly "19" may continue southeastward to join with an axis trending east-west through Anomaly "22a". Part of this axis is coincident with a high fracture density trend.

Anomaly "20" - A broadly circular pattern on the west side of Keith Arm is designated as Anomaly "20". The circular pattern is drawn mainly on the basis of the pattern of lakes. Anomaly "20" is located on the east side of the "Franklin Hills", which have been discussed under Physiography. This circular pattern seems to continue downward from the Hills to the outline of the Keith Arm. The significance of this circular pattern is unknown. However, it could represent a large dome in the subsurface. It appears that glaciation through this region was deflected westward around this highland, thus indicating a preglacial highland.

Sheet 2

Anomaly "21" - A small circular pattern of streams apparent on the mosaic, but not shown on the base map, has been described as Anomaly "21". A very sharp deflection in one of the tributaries to Porcupine River controls the position of the axis drawn through "21". The broad arcuate pattern of Bear River, as it drains from Great Bear Lake, may also suggest anomalous subsurface conditions in the vicinity of this anomaly.

Anomaly "22" - Anomaly "22" contains a general east-west trending geomorphic axis, which is coincident with Anomaly "K", a high fracture density zone on the Macro-Fracture Analysis Maps. This axis is controlled by drainage patterns, and a tonal pattern which has been delineated as "22a". Anomaly "22b" on the east, is defined by a number of sharp stream deflections. It appears to contain an intersection of axes; one previously mentioned which extends in an east-west direction, and a second axis which appears to be a continuation of Anomaly "23" in a northwest direction. This northwest trending axis may join with an axis through Anomaly "9" on the north side of Great Bear Lake. This northwesterly trending axis is controlled by stream deflections and concentric tonal patterns and is quite well defined.

If the axis through "22a" were continued southwestward, it would join an area of significant offsetting in the Franklin Mountain Front. The geomorphic axis is coincident with a high fracture density trend axis through the north-central part of the map sheet. The high fracture density trend continues southwestward to the offset in the mountain front.

Anomaly "23" - A long axis has been drawn from "23c", northwesterly to "23a" where it appears to bifercate with one member extending westerly towards Anomaly "18c" and the other member extending northwesterly through "22b". The westerly trending leg of this axis is well controlled by broadly annular stream courses near "18c". The general northwesterly trend through Anomalies "23a" to "23c" is controlled by tonal patterns and arcuate drainage at "23a", annular drainage between "23a" and "23b", annular drainage at "23b", and arcuate drainage and a tonal anomaly at "23c". The western leg of this axis is subparallel to the axis drawn between "22a" and "22b". It may indicate a radical departure from the regional tectonic grain. The western leg of the axis through Anomalies "23" and "18c" may continue into a zone of significant disturbance on the Franklin Mountain front.

Anomaly "24" - Anomaly "24" is delineated by an area of anomalous low topography. It contains broadly arcuate stream courses, intense stream meandering, and a slight tonal pattern. This area may actually be an area of ice-disintegration. A geomorphic axis has been drawn through "24a" to coincide with the overall trend of the elements of this anomaly. This axis continues southeasterly to a strong tonal pattern and slight arcuate drainage. In the vicinity of Anomaly "24b" the glacial grooves appear to be deflected westerly, probably around a preglacial topographic high. Departures from the regional glacial groove pattern also occur southwest of "24a", where the glacial grooves trend northeasterly and may indicate that a lobe of ice was deflected to the southwest, or was constricted between a topographic high in the vicinity of Anomaly "25" and the mountain front through the Blackwater Lake drainage, northeastward to join with the regional ice sheet in the vicinity of "24a". Anomaly "24" and its trend axis are generally coincident with a high fracture density pattern through "P_2".

Anomaly "25" - Geomorphic axes drawn through Anomaly "25" and "26" have been delineated as anticlines and synclines respectively. This designation is based primarily on anticlinal and synclinal interpretations shown on the photogeologic evaluation (Geophoto Services, Ltd., 1963). The axis through Anomaly "25" is very well controlled by geomorphic criteria, including; tonal patterns at "25a", tonal and arcuate drainage patterns at "25b"; drainage patterns at "25c" and "25d"; drainage deflections, tonal patterns, a constricted stream course, and topographic flattening between "25d" and "25c"; tonal patterns and topographic highs at "25c"; and arcuate drainage at "25f". There is some evidence at "25b" and on streams to the northeast that the axis between "23" and "18" may continue southwestward into the mountain front in this area.

Anomaly "26" - Anomaly "26" is delineated at the south end of a syncline shown extending between Anomaly "25" and the mountain front. It is delineated at this location, to point out a radial drainage pattern and an anomalous topographic flattening zone. There is evidence on the Macro-Fracture Analysis Maps, of a very prominent fault trend extending northeastward from the mountains through Anomaly "26". This fault zone may pass through Anomaly "24a" to the northeast. This anomaly is partially coincident with Anomaly "W" on the Macro-Fracture Analysis Maps.

Anomaly "27" - Anomaly "27" is located in the southeast part of Sheet 2 and barely enters the project area. However, the anomaly has been designated within an area of very low topography, and an axis has been drawn northwestward through several stream deflections, subparallel to the axis trending through Anomaly "23". This axis may continue northwestward into the vicinity of Anomaly "23a". A stream which passes to the north of Anomaly "23c" is strongly deflected in convex and concave fashion, with anomalous stream constrictions and meanders. These deflections may indicate that axes of structural significance pass through this area at an angle oblique to the glacial grooving.

SUMMARY AND CONCLUSIONS

A geomorphic and macro-fracture analysis has been completed on approximately 8,500 square miles in the Franklin area of the Northwest Territories. Twenty-four areas have been designated as anomalous and described in the report of the Macro-Fracture Analysis. Gross Interpretation Overlays have been prepared to the Macro-Fracture Analysis Maps, and contain fracture density trend lines and those lineaments interpreted as most significant in this study. Twenty-seven anomalies have been designated on the Geomorphic Analysis Maps. Some of these anomalies contain geomorphic trend axes, which have been interpreted as anticlines and synclines. Where possible, the structural significance of the geomorphic and fracture trend axes have been correlated with features in the Franklin Mountains, which border the project on the west. The two studies have been conducted entirely independant of each other, and their results have been intercalated in the following paragraphs. Fracture anomalies are designated with capital letters and geomorphic anomalies are referred to by numbers.

It is recommended that in studying the Geomorphic Analysis Maps, that the Gross Interpretation Overlays from the Macro-Fracture Analysis be superimposed on the Geomorphic Analysis Maps. This will facilitate the recognition of coincident anomalies.

The relationship of the fracture density pattern to subsurface features is dependant on the magnitude of the subsurface structures involved, lithology, paleotopography, and regional and local tectonics. It is believed that low and intermediate fracture density patterns will reflect subsurface highs or lows and high fracture density patterns will reflect zones of significant subsurface change. The geomorphic axes may reflect either zones of subsurface highs or lows. A good correlation appears to exist between structural features on the mountain front and interpreted anticlines and synclines.

On Sheet 1, the most significant feature of the Macro-Fracture Analysis appears to be a zone of northeasterly trending macro-fractures extending from the Bracket Lake Fault area, northeastward. There are several terminations of fracture density patterns along this postulated fault zone as well as termination of geomorphic axes, particularly in the vicinity of geomorphic Anomalies "7", "8", "9" and "18".

A possible anticlinorium has been postulated in the vicinity of Anomalies "6a" and "6b", where the Whitefish River is strongly deflected around a topographic high. If such an anticlinorium is present, then it may be controlled by faulting on the south side. Isolated geomorphic features on the northeast part of the map sheet may be local features such as reefs in the subsurface.

A low fracture density trend designated as Anomaly "F" on the Macro-Fracture Analysis Map, is partially coincident with Anomalies "10a" and "10b".

A very long, low fracture density trend extends north-south, and has been delineated as Anomaly "J". Anomaly "J_2" is coincident with geomorphic Anomaly "13".

A large area of low and intermediate fracture density is found in the vicinity of geomorphic Anomalies "5" and "6a" and "6b". A high fracture density axis has been postulated to trend northeasterly between geomorphic Anomalies "6a" and "6b". However, there is no evidence on the geomorphic study to indicate a northeast trend at this location.

Fracture Anomaly "A", in the northwest part of Sheet 1, may in part, be a reflection of a postulated dome or anticline as discussed in the geomorphic study. The trend of fracture Anomaly "A" may, in part, be eronious due to "edge fall-off" adjacent to the project boundary.

Geomorphic Anomalies "1" and "2" contain trend lines extending northeasterly. The Macro-Fracture Analysis also indicates a possible high trend extending east-northeasterly between "1a" and "1b" and through geomorphic Anomaly "2". This fracture density trend is subparallel to an anticline shown to the west of the project on the photogeologic evaluation. A very distinct macro-fracture, upon which a fault has been postulated, with the upthrown side located on the north, is located south of Anomaly "B". The trend axis through geomorphic Anomaly "2" terminates against this major macro-fracture.

Anomaly "3a" is partially coincident with fracture Anomaly "C_1". A geomorphic trend axis through "3a" may terminate against a north trending, very distinct macro-fracture which passes through fracture Anomaly "C_1".

A low fracture density trend line extends northward through geomorphic Anomaly "4" which is believed to be very significant and a possible indicator of an anticline.

One of the best coincidences of fracture and geomorphic data occurs at fracture Anomalies "D_2" and "D_3", which are nearly coincident with geomorphic Anomaly "17" and its geomorphic trend axis. At this location, a low fracture density trend is parallel and nearly coincident with the geomorphic trend. To the east of fracture Anomaly "D_2", a subparallel, high fracture density zone is partially coincident with Anomaly "18" on the geomorphic study.

Another high fracture density trend axis is found to extend northwesterly through Anomaly "19b" towards a geomorphic trend axis through Anomaly "6".

On Sheet 2, there are several significant correlations of the two studies. Perhaps the most important of these is located on the north part of Sheet 2, where fracture Anomaly "K", which is generally a very high fracture density zone, is partially coincident with geomorphic Anomaly "22". On both studies, the general east-west trend is a significant departure from regional features. The fracture pattern is also correlative with an offset in the outcrop pattern as shown on the photogeologic evaluation. The geomorphic axis could probably be extended to the same area. Anomaly "K" may indicate a northeast trending subsurface high which could have divided the sedimentary basin into two parts. On the other hand, it may indicate a feature such as a barrier reef or a zone of culmination of northwesterly trends against a basement zone of faulting. It is believed that this area certainly warrants further investigation.

Fracture Anomaly "L" trends northeasterly against the geomorphic grain. However, this low fracture density zone generally contains Anomalies "17b" and "25a" which may indicate an additional northeasterly trending subsurface feature extending from the mountains, northeastward.

A very distinct macro-fracture, trending N50°E, has been located near the center and northeastern parts of the map sheet. This lineament has been interpreted to be a significant basement fault which may extend southwestward into the Mackenzie Basin and beyond. Two geomorphic trend axes, passing through Anomalies "17" and "18" appear to terminate north of this feature.

At Anomaly "23a", there is a significant re-orientation of geomorphic trends and a bifercation of trends has been postulated. This feature may be controlled by basement faulting and lateral movement.

A high fracture density anomaly has been designated as "P_2" and is partially coincident with Anomaly "24a". The trend axis through Anomaly "24" on the geomorphic study, is subparallel to the high fracture density trend through "P_2". The area is topographically low and appears quite anomalous on the geomorphic study; therefore anomalous fracture conditions may exist. High fracture density Anomaly "V" is partially coincident with geomorphic Anomaly "25f". A high fracture density trend continues northward from Anomaly "V" to join with Anomaly "24b" on the geomorphic study, which may indicate a relationship between Anomalies "24b" and "25f".

A low fracture density trend extends southeastward into the vicinity of geomorphic Anomaly "27" which cannot be accurately delineated without studying the area to the east of the project boundary. However, the fracture density axis is partially parallel and on trend with an axis through geomorphic Anomaly "27" which may indicate that the geomorphic axis should be carried northward parallel to the geomorphic axis through Anomaly "23".

In conclusion, the most significant aspects and anomalous conditions of this study should be pointed out. First, it is believed that the geomorphic trend axis which have been postulated as anticlines or synclines, and are nearest to the mountain front, have very good reliability. This pattern of high and low structural features may continue from 10 to 15 miles east of the mountain front.

Secondly, the northeast trending fracture density zone, designated as Anomaly "K" on Sheet 2, is coincident with an anomalous geomorphic trend axis. This area may indicate a zone of significant subsurface change, such as a paleotopographic high, basement horst, or barrier reef.

Geomorphic axes through Anomalies "15a" and "14" are subparallel to an anticline delineated on the photogeologic study, immediately south of Mahoney Lake and may indicate a continuation of anticlinal and synclinal features to the east of the delineated anticline.

vicinity of geomorphic Anomaly "27" which cannot be accurately delineated without studying the area to the east of the project boundary. However, the fracture density axis is partially parallel and on trend with an axis through geomorphic Anomaly "27" which may indicate that the geomorphic axis should be carried northward parallel to the geomorphic axis through Anomaly "23".

In conclusion, the most significant aspects and anomalous conditions of this study should be pointed out. First, it is believed that the geomorphic trend axis which have been postulated as anticlines or synclines, and are nearest to the mountain front, have very good reliability. This pattern of high and low structural features may continue from 10 to 15 miles east of the mountain front.

Secondly, the northeast trending fracture density zone, designated as Anomaly "K" on Sheet 2, is coincident with an anomalous geomorphic trend axis. This area may indicate a zone of significant subsurface change, such as a paleotopographic high, basement horst, or barrier reef.

Geomorphic axes through Anomalies "15a" and "14" are subparallel to an anticline delineated on the photogeologic study, immediately south of Mahoney Lake and may indicate a continuation of anticlinal and synclinal features to the east of the delineated anticline.

Geomorphic Anomalies "6", "7", "8" and "9", contain northwesterly trending axes which generally enter a very broad deflection of the Whitefish River. These axes may be part of a subsurface high or anticlinorium in that area. Anomalous conditions in this area are further indicated by fracture density Anomaly "E". Many long northerly trending geomorphic axes appear in the vicinity of Anomaly "6".

A fracture density anomaly, at "A", may be related to a dome or anticline extending through the northwest corner of the project boundary. Anomalous geomorphic conditions are present south of Anomaly "A".

Very important faults are postulated to extend northeasterly from the Bracket Fault area of the photogeologic study. A significant basement fault may trend N50°E across map Sheet 2. Evidence of subsurface or basement control of thrust faulting from the west has been indicated in the Macro-Fracture Analysis. These controls may be best represented by fracture density Anomalies "L", "R" and "S" on the Macro-Fracture Analysis Maps, which are interpreted to be basement highs which have created an upward deflection of low angle faults.

Many geomorphic and macro-fracture anomalies have been delineated on the maps and discussed in the report of this area. The intense glacial grooving and numerous lakes have hindered the interpretation of the surface conditions in this area. However, the results of the investigation seem to indicate that some very good features mentioned in the above paragraphs, do exist and are worthy of additional investigation by other tools of subsurface exploration. It is believed that the geomorphic axes is general, may be more reliable than the fracture density axes with the possible exception of macro-fracture Anomaly "K". The overall fracture density pattern seems to indicate paleotopographic control. However, some indication by other subsurface tools will be necessary to confirm this interpretation.

Respectfully submitted,

GEOPHOTO SERVICES, LTD.

T. J. French

T. J. French

Paul Fuenning

Paul Fuenning

SELECTED REFERENCES

Barton, R.H., and Broscoe, A.J., 1960, The geomorphic expression of selected concealed structures in Western Canada: in Frontiers of exploration in Canada, Preprints of Papers, Alberta Soc. Petrol. Geologists.

Barton, R.H., 1962, Differential isostatic rebound, possible mechanism for fault reflection through glacial drift: Am. Assoc. Petrol. Geologists Bull., v. 46, no. 12, p. 2253-2254.

Belcher, D.J., and Schepis, E.L., 1965, Exploration theory can aid oil hunters: Oil and Gas Jour., v. 63, no. 48, p. 108-113.

Blanchet, P.H., 1957, Development of fracture analysis as an exploration method: Am. Assoc. Petrol. Geologists Bull., v. 41, no. 8, p. 1748-1759.

Bostock, H.S., 1948, Physiography of the Canadian Cordillera with special reference to the area north of the fifty-fifth parallel: Canada Geol. Survey Mem. 247, p. 106.

Byers, A.R., 1962, Major faults in western Canadian Shield: in the tectonics of the Canadian Shield, J.S. Stevenson, ed., Royal Soc. Canada Spec. Paper no. 4, p. 51-54.

Carson, C.E., and Hussey, K.M., 1962, Oriented lakes of Arctic Alaska: J. Geol., v. 70, no. 4, p. 417-439.

Craig, B.G., and Fyles, J.G., 1960, Pleistocene geology of Arctic Canada: in Geology of the Arctic, Raash, G.O., ed., vol.1, U. Toronto Press, p. 403-420.

Flint, R.F., 1957, Glacial and Pleistocene Geology: New York, John Wiley and Sons, 553 p.

Geological Survey of Canada, 1963, Yukon Territory and Northwest Territories; Dept. Mines Tech. Surveys, Geol. Survey Canada Map 30-1963.

Geophoto Services, Ltd., 1963, Photogeologic evaluation of the Mackenzie Basin area, N.W.T.; prepared for Sinclair Canada Oil Co.: Calgary, Geophoto Services, Ltd., p. E1-E92 and F1-F21.

Godfrey, J.D., 1958, Aerial photographic interpretation of Precambrian structures north of Lake Athabasca: Res. Council Alberta, Geol. Div. Bull. 1, 19 p.

Goodman, A.J., 1951, Tectonics of east side of Cordillera in western Canada: Am. Assoc. Petrol. Geologists Bull., v. 35, no. 4, p. 783-795.

Haites, T.B., 1960, Transcurrent faults in western Canada: Jour. Alberta Soc. Petrol. Geologists, v. 8, no. 2, p. 33-78.

Hodgson, R.A., 1965, Genetic and geometric relations between structures in basement and overlying sedimentary rocks, with examples from Colorado Plateau and Wyoming: Am. Assoc. Petrol. Geologists Bull., v. 49, no. 7, p. 935-949.

Lattman, L.H., 1958, Technique of mapping geologic fracture traces and lineaments on aerial photographs: Photo. Eng., v. 24, no. 4.

Leopold, L.B., Wolman, M.G., and Miller, J.D., 1964, Fluvial processes in geomorphology: San Francisco, W. H. Freeman and Company, 522 p.

Mackay, J.R., 1963, The Mackenzie Delta area, N.W.T. and Yukon: Dept. Mines and Tech. Surveys, Geol. Branch, Mem. 8, 118p.

Martin, L.J., 1960, Tectonic framework of northern Canada: in Geology of the Arctic, Raash, G.O., ed., Vol. 1, U. Toronto Press, p. 403-420.

Mollard, J.D., 1958, Photogeophysics - its application in petroleum exploration over the glaciated plains in western Canada: Saskatchewan Geol. Soc. Williston Basin Symposium, 2nd Internat., Regina, Saskatchewan, Apr., 1958, p. 109-117.

Muller, F., and Barr, W., 1966, Postglacial isostatic movement in northeastern Devon Island, Canadian Arctic Archipelago: J. Arctic Inst. of N. America, v. 9, no. 3, p. 263-269.

Plafker, George, 1964, Oriented lakes and lineaments of northeastern Bolivia: Geol. Soc. America Bull., v. 75, no. 6, p. 503-522.

Smith, H.T.U., 1958, Giant glacial grooves in northwest Canada: Am. Jour. Sci., v. 246, p. 503-514.

GLOSSARY

MACRO-FRACTURE - (General definition). Air photo lineament of greater than 2 miles in length. Composed of linear topography, vegetal changes, soil patterns, photographic tones, or a combination of the four. The term "lineament" is generally used interchangeably with "macro-fracture".

VERY DISTINCT MACRO-FRACTURE - Air photo lineament as defined by the general definition above, characterized by very strong photo expression, extreme length, or both. Shown on original data sheets and final maps as a heavy black line. Interpreted to indicate a Pre-cambrian basement fault.

DISTINCT MACRO-FRACTURE - Air photo lineament as defined by the general definition above. Similar to the Very Distinct Macro-Fracture but not quite as well defined on the photo mosaic. This category is annotated only on mosaics of 1" to 1 mile scale. May be indicative of basement faulting. Shown on original data sheets as a heavy dashed black line and on final maps as a thin solid black line.

INDISTINCT OR FAINTLY EXPRESSED MACRO-FRACTURE - Air photo lineament, as defined by the general definition above. Majority of air photo lineaments fall into this category. The large number of these lineaments form the density pattern. They are characterized by their faint photo expression and can only be seen by concentrated viewing of the mosaic under intense light and at a low eye to mosaic angle. Indistinct macro-fractures may indicate basement faulting or faults and joints resulting from differential compaction of beds over various subsurface features including; basement horsts, anti-clines, reefs, and competent strata.

MESO-FRACTURE - (General definition). Air photo lineament of less than 2 miles in length. Composed of linear topography, vegetal changes, soil patterns or photographic tones. These features are annotated on a mosaic at a scale of 1 inch to 1 mile. They average about 0.6 mile in length.

125°00'
45'
30'
15'
124°00'
45'
30'
15'
123°00'
45'
30'
15'
122°00'
65°00'
65°00'
50'
40'
30'
20'
10'
KEITH ARM
(GREAT BEAR LAKE)
D3
K1
K2
K3
M1
M2
M3
M4
N
L
O
R
S
P1
P2
Q
T
U
V
W
X
OLD FORT POINT
MACKENZIE
RIVER
SALINE RIVER
REDSTONE
BIRCH ISLAND
KEELE
BLACKWATER LAKE
West Boundary of Macro Fracture Data
Fractures probably obscured by lakes and glacial drift
MT. CLARK
ABANDONED CAMP
1 of

MACRO F
FRA
66°00'
30'
15'
125°00'
45'
124°00'
123°00'
50'
40'
20'
10'
BYDAND
BAY
(GREAT BEAR LAKE)
FORD BAY
TATUI
LAKE
DEERPASS
BAY
WHITE
LOSH
LAKE
TUTATUI
LAKE
LOST
HILL
LAKE
MAN DROWNED
HIMSELF LAKE
KEKWINATUI
LAKE
WHITE
WATER
LAKE
WHITEFISH
RIVER
MAHONY
LAKE
BRACKETT
LAKE
KEITH
ARM
FOX POINT
RUSSEL BAY
FORT
FRANKLIN
(GREAT BEAR LAKE)
Fractures probably obscured by lakes and glacial grooves
A
B
C1
C2
D1
D2
E
F1
F2
G
H1
I
J1
J2
J3
J4
1 of


66°00'
30'
15'
125°00'
45'
30'
15'
124°00'
45'
30'
15'
123°00'
45'
30'
66°00'
50'
40'
30'
20'
10'
65°00'
Note: Strong deflection of Indian River, possible bedrock dip, and possible tension fractures in glacial drift may indicate a NNE trending anticline or dome extending through NW corner of project. See photo No. A12 609-289
BYDAND
BAY
(GREAT BEAR LAKE)
FORD BAY
(GREAT BEAR LAKE)
Topographic high continues northward across Smith Arm.
Drainage texture probably reflects lithologic control by fine-grained outwash deposits.
TATUI
LAKE
DEERPASS
BAY
Strong tonal lineaments have no topographic relief.
Topographic Low
Topographic high
Sharp change in glacial groove pattern may indicate northeasterly trending subsurface feature.
WHITE LOSH LAKE
Topographic Low
MAN DROWNED HIMSELF LAKE
LOST
HILL
LAKE
WHITEFISH
MAHONY
LAKE
Axis based on tonal pattern
KEITH
ARM
FOX POINT
BRACKETT
LAKE
BRACKETT
Grooves 300 feet wide, approximately 50 feet deep and up to 8 miles long. (Smith, 1948)
Four or more lake terrace levels.
Many strand lines
FORT FRANKLIN
(GREAT BEAR LAKE)
GREAT
BEAR
RIVER
1a
1b
2
3a
3b
4
5
6a
6b
6c
7
8
9a
9b
10a
10b
11
12
13
14
15a
15b
15c
16
17a
18a
18b
19a
19b
20
21
1 of

INDIAN VILLAGE
RIVER
KEELE
BURNT PT
ABANDONED CAMP
SALINE
RIVER
WINTER
RANGE
FAULT
ZONE
TRACTOR
ROUTE
M4
W
U
V
BIRCH ISLAND
REDSTONE
RIVER
BLACKWATER
LAKE
C.S.L.
BM 299
BM 273
BM 274
BM 293
50W
65W
60E
50E
25W
15E
20E
20'
10'
64°00'
125°00'
45'
30'
15'
124°00'
123°00'
122°00'
3 of

RECONNAISSANCE

MACRO FRACTURE ANALYSIS MAP
FRANKLIN AREA N.W.T.

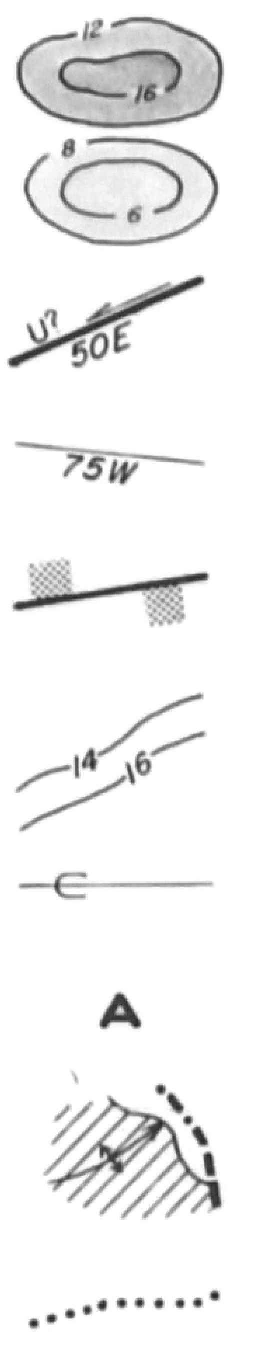
PREPARED FOR
SINCLAIR CANADA OIL COMPANY

0 1/2 1 1 1/2 2 4 6 MILES

SCALE: 1 INCH = 2 MILES

1966

EXPLANATION



HIGH MACRO-FRACTURE DENSITY (ARBITRARILY SELECTED).

LOW MACRO-FRACTURE DENSITY (ARBITRARILY SELECTED).

VERY DISTINCT MACRO-FRACTURE INTERPRETED AS A FAULT. NUMBER INDICATES BEARING. ARROW INDICATED INTERPRETED DIRECTION OF FAULT MOVEMENT. "U?" INDICATES POSSIBLE UPTHROWN SIDE.

DISTINCT MACRO-FRACTURE. NUMBER INDICATES BEARING.

STIPPLED PATTERN REPRESENTATIVE OF ZONE OF SIGNIFICANT LINEAMENT TERMINATIONS AND OFFSETS ALONG MAJOR MACRO-FRACTURE.

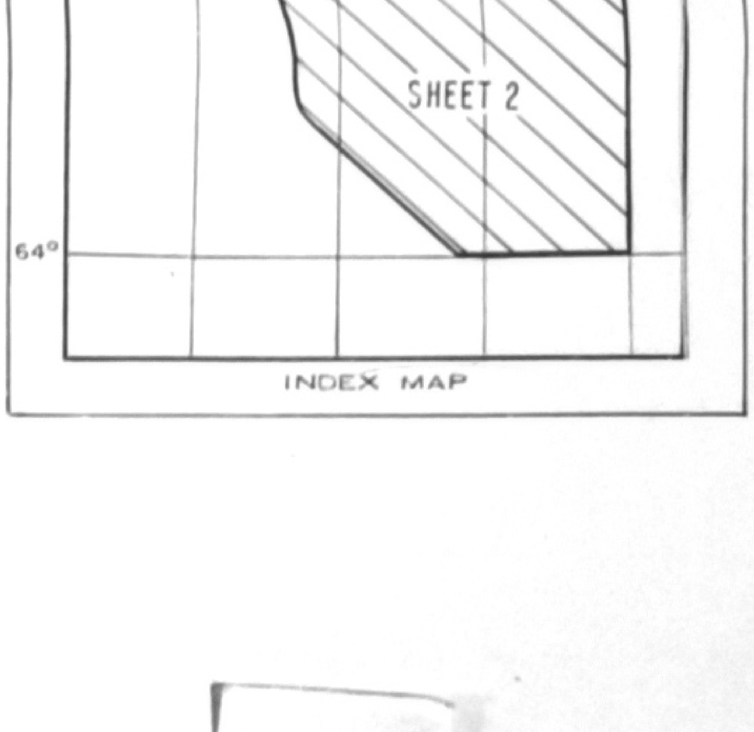
FRACTURE DENSITY CONTOURS BASED ON TOTAL NUMBER OF LINEAMENTS INTERSECTING A 1 INCH (4 SQUARE MILES) GRID. CONTOUR INTERVAL = 2 LINEAMENTS PER 4 SQUARE MILES.

GLACIAL GROOVE. DIRECTION OF GLACIAL MOVEMENT INDICATED.

ANOMALY AS DESCRIBED IN REPORT.

FAULTS, ANTICLINES, SYNCLINES AND EASTERN EXTENT OF OUTCROP AS SHOWN BY PREVIOUS PHOTOGEOLOGIC EVALUATION OF MACKENZIE BASIN AREA, N.W.T. (GEOPHOTO SERVICES, LTD., 1963).

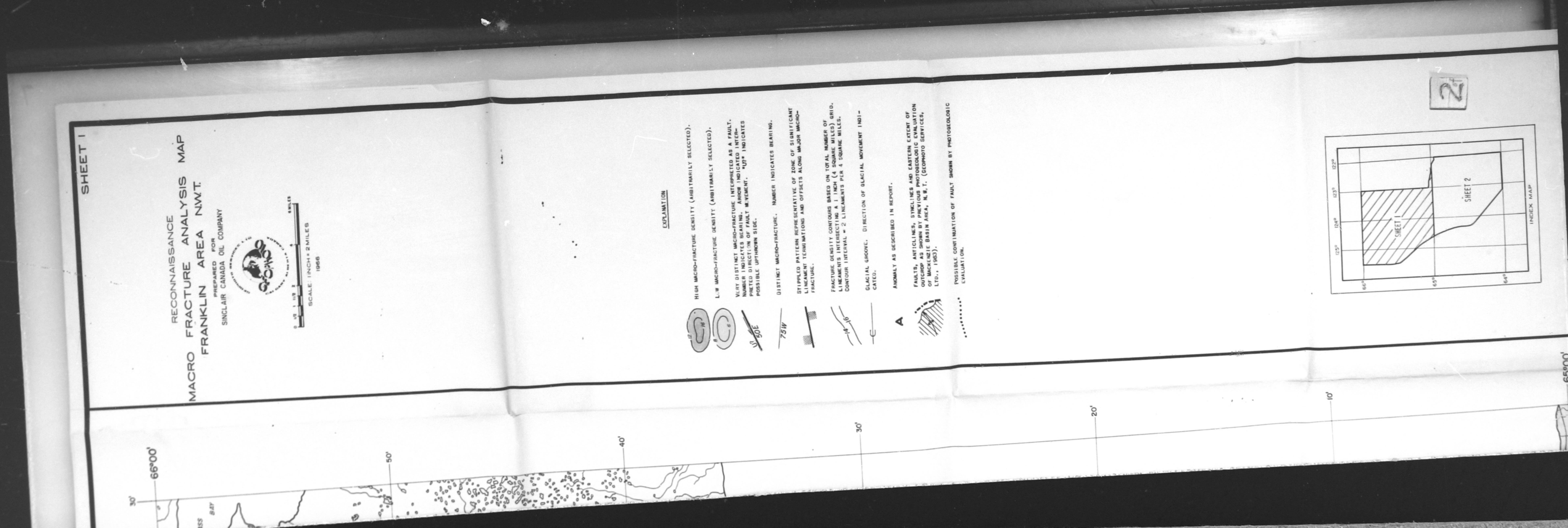
POSSIBLE CONTINUATION OF FAULT SHOWN BY PHOTOGEOLOGIC EVALUATION.



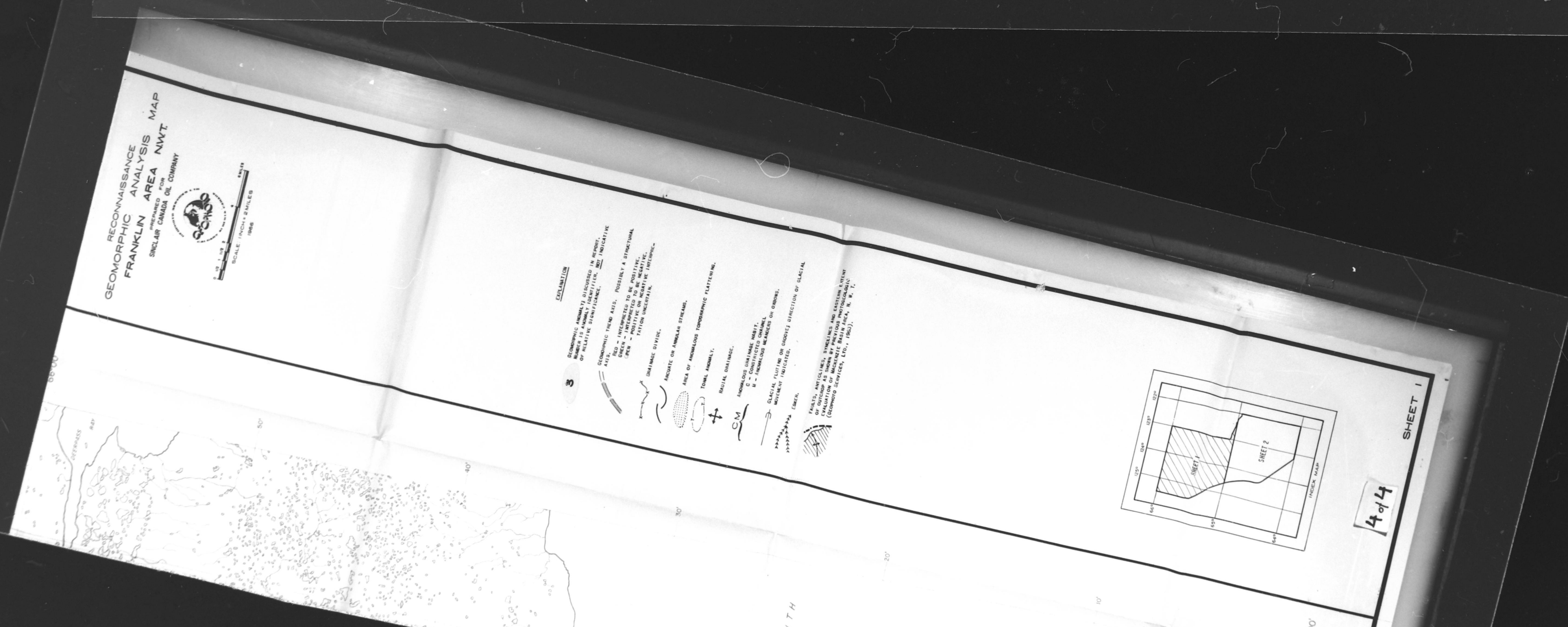
4 of 4

SHEET 2

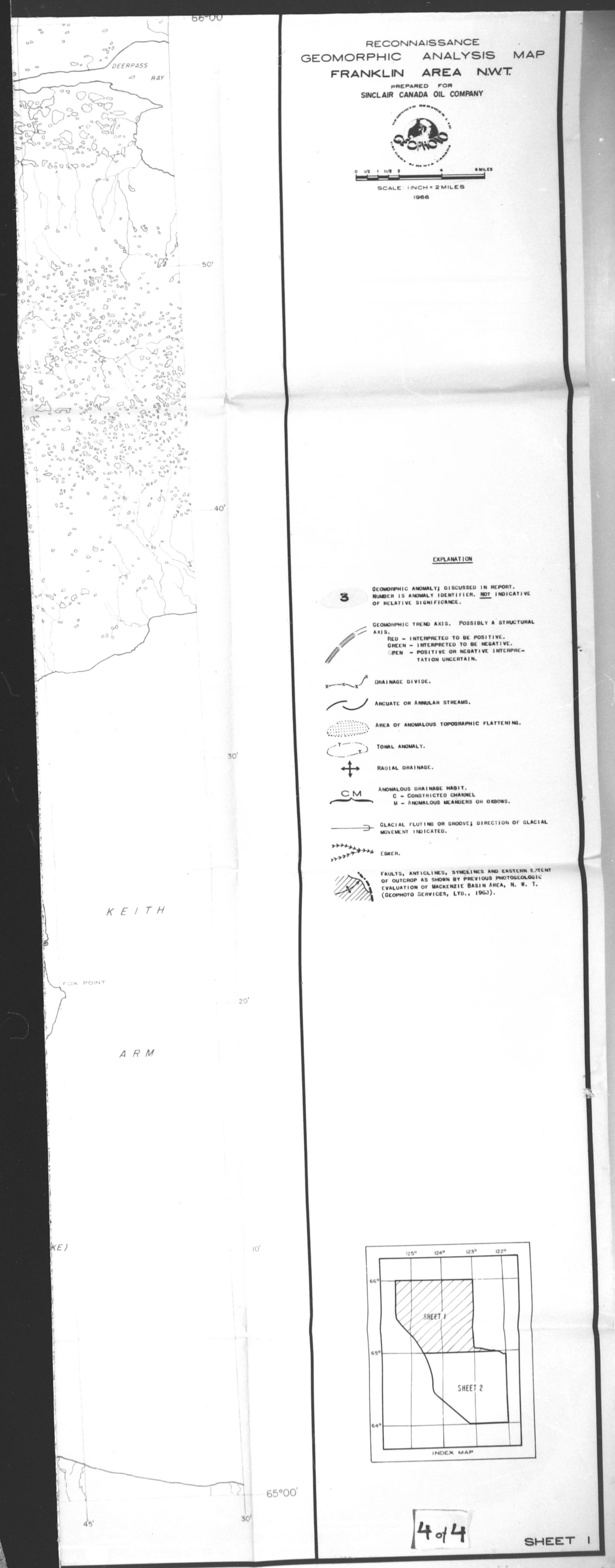

BRACKETT LAKE
ARM
D2
H1
H2
(GREAT BEAR LAKE)
FORT FRANKLIN
GREAT BEAR RIVER
RIVER
CHARLES RAPIDS
BENNETT AIR STRIP
65°00'
125°00'
124°00'
123°00'
3 of


SHEET 1
RECONNAISSANCE
MACRO FRACTURE ANALYSIS MAP
FRANKLIN AREA N.W.T.
PREPARED FOR
SINCLAIR CANADA OIL COMPANY
SCALE: 1 INCH = 2 MILES
1966
EXPLANATION
HIGH MACRO-FRACTURE DENSITY (ARBITRARILY SELECTED).
LOW MACRO-FRACTURE DENSITY (ARBITRARILY SELECTED).
VERY DISTINCT MACRO-FRACTURE INTERPRETED AS A FAULT. NUMBER INDICATES BEARING. ARROW INDICATED INTERPRETED DIRECTION OF FAULT MOVEMENT. "UP" INDICATES POSSIBLE UPTHROWN SIDE.
DISTINCT MACRO-FRACTURE. NUMBER INDICATES BEARING.
STIPPLED PATTERN REPRESENTATIVE OF ZONE OF SIGNIFICANT LINEAMENT TERMINATIONS AND OFFSETS ALONG MAJOR MACRO-FRACTURE.
FRACTURE DENSITY CONTOURS BASED ON TOTAL NUMBER OF LINEAMENTS INTERSECTING A 1 INCH (4 SQUARE MILES) GRID. CONTOUR INTERVAL = 2 LINEAMENTS PER 4 SQUARE MILES.
GLACIAL GROOVE. DIRECTION OF GLACIAL MOVEMENT INDICATED.
ANOMALY AS DESCRIBED IN REPORT.
FAULTS, ANTICLINES, SYNCLINES AND EASTERN EXTENT OF OUTCROP AS SHOWN BY PREVIOUS PHOTOGEOLOGIC EVALUATION OF MACKENZIE BASIN AREA, N.W.T. (GEOPHOTO SERVICES, LTD., 1963).
POSSIBLE CONTINUATION OF FAULT SHOWN BY PHOTOGEOLOGIC EVALUATION.
SHEET 1
SHEET 2
INDEX MAP
2
65°00'
66°00'

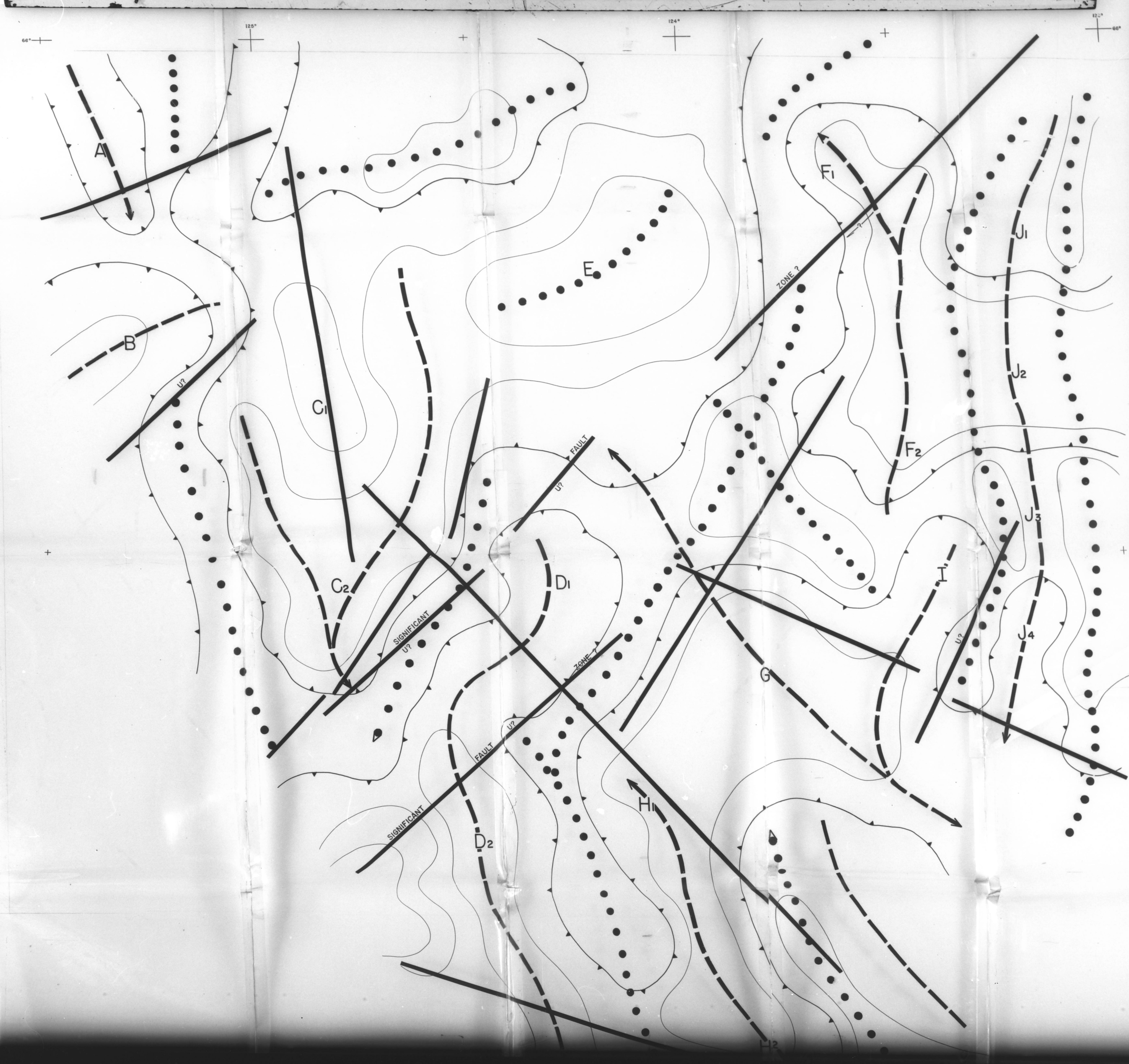
14
15b
18a
6c
9b
20
16
17a
18b
15c
19a
21
19b
BRACKETT LAKE
ARM
(GREAT BEAR LAKE)
Four or more lake terrace levels.
Many strand lines
Grooves 300 feet wide, approximately 50 feet deep and up to 8 miles long. (Smith, 1948)
GREAT BEAR RIVER
RIVER
65°00'
125°00'
124°00'
123°00'
3 of



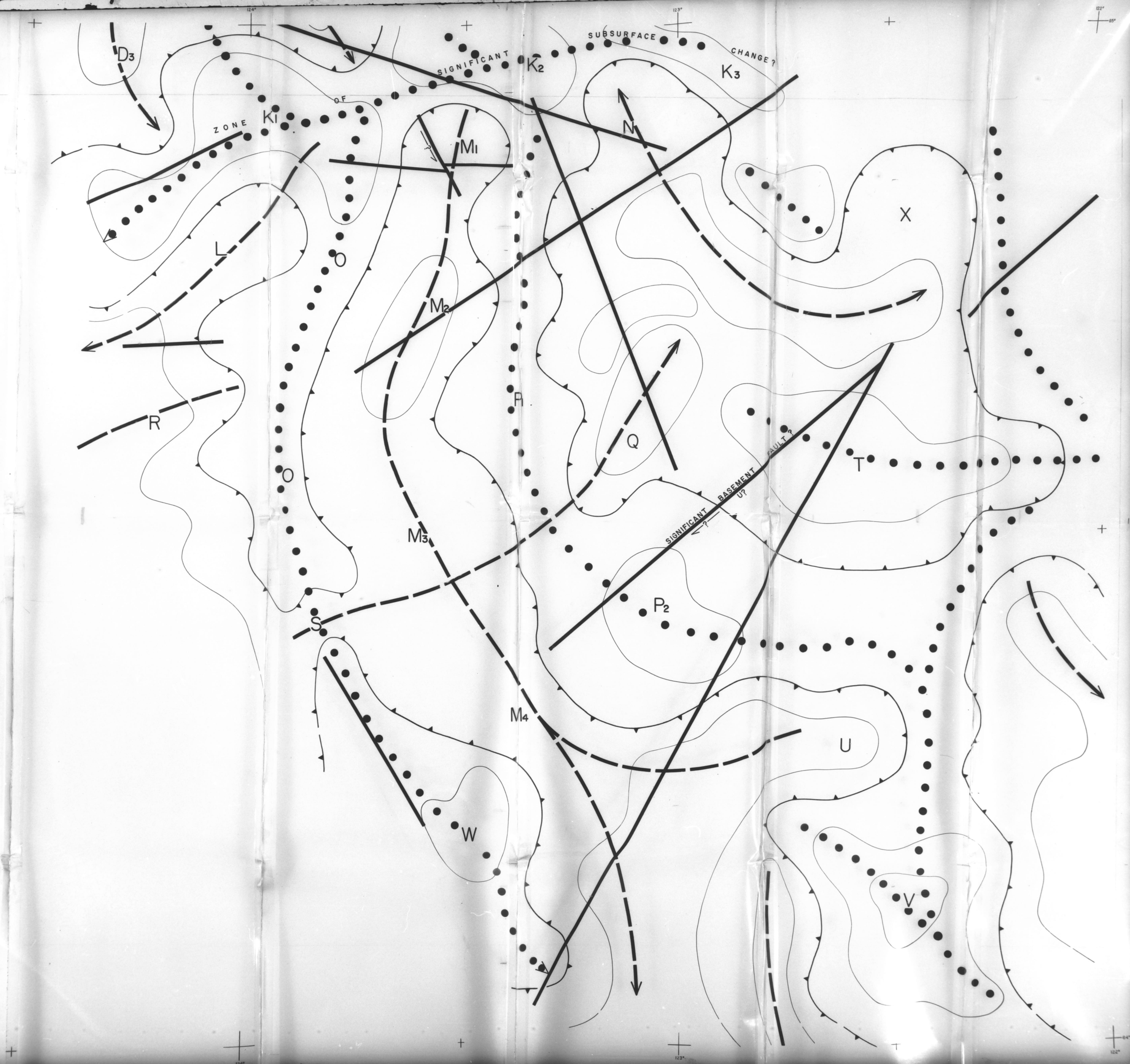
RECONNAISSANCE
GEOMORPHIC ANALYSIS MAP
FRANKLIN AREA NWT
PREPARED FOR
SINCLAIR CANADA OIL COMPANY
EXPLANATION
SHEET 1
SHEET 2
4 of 4


RECONNAISSANCE
GEOMORPHIC ANALYSIS MAP
FRANKLIN AREA N.W.T.
PREPARED FOR
SINCLAIR CANADA OIL COMPANY
SCALE: 1 INCH = 2 MILES
1966
EXPLANATION
3 GEOMORPHIC ANOMALY; DISCUSSED IN REPORT. NUMBER IS ANOMALY IDENTIFIER. NOT INDICATIVE OF RELATIVE SIGNIFICANCE.
GEOMORPHIC TREND AXIS. POSSIBLY A STRUCTURAL AXIS.
RED - INTERPRETED TO BE POSITIVE.
GREEN - INTERPRETED TO BE NEGATIVE.
OPEN - POSITIVE OR NEGATIVE INTERPRETATION UNCERTAIN.
DRAINAGE DIVIDE.
ARCUATE OR ANNULAR STREAMS.
AREA OF ANOMALOUS TOPOGRAPHIC FLATTENING.
TONAL ANOMALY.
RADIAL DRAINAGE.
CM ANOMALOUS DRAINAGE HABIT.
C - CONSTRICTED CHANNEL
M - ANOMALOUS MEANDERS OR OXBOWS.
GLACIAL FLUTING OR GROOVE; DIRECTION OF GLACIAL MOVEMENT INDICATED.
ESKER.
FAULTS, ANTICLINES, SYNCLINES AND EASTERN EXTENT OF OUTCROP AS SHOWN BY PREVIOUS PHOTOGEOLOGIC EVALUATION OF MACKENZIE BASIN AREA, N. W. T. (GEOPHOTO SERVICES, LTD., 1963).
KEITH
ARM
66°00'
65°00'
SHEET 1
SHEET 2
INDEX MAP
4 of 4
SHEET 1

KEITH ARM
(GREAT BEAR LAKE)
Strand lines and terraces
Axis based on tonal pattern
Many ice disintegration features
Lake positions, shapes and orientation due to glacial grooves
Stream habit and deflections suggest possible structural control
Topographic Low
Topographic High
Glacial grooves appear deflected westerly
Numerous ice disintegration features
MACKENZIE
RIVER
BLACKWATER
LAKE
OLD FORT POINT
BIRCH ISLAND
REDSTONE
SALINE
PORCUPINE
15d
17b
17c
18c
18d
22a
22b
23a
23b
23c
24a
24b
25a
25b
25c
25d
25e
25f
26
27
125°00'
124°00'
123°00'
122°00'
65°00'



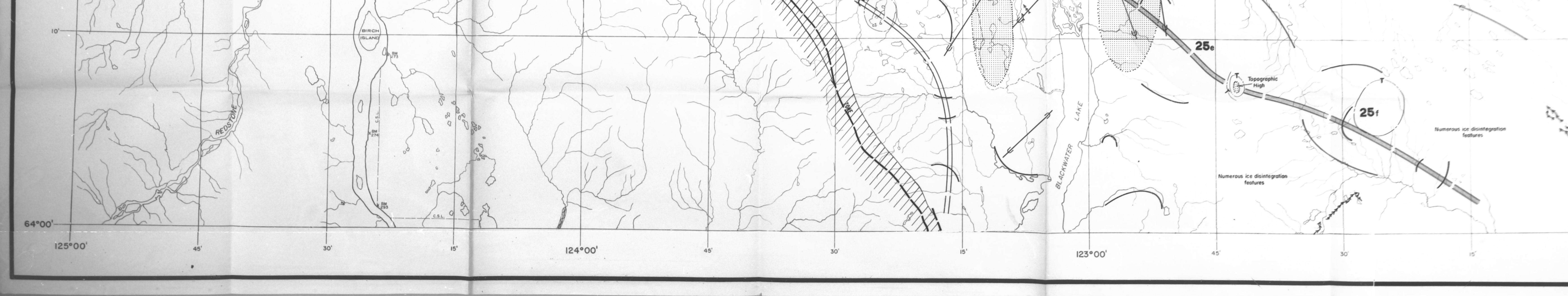
66°
125°
124°
123°
66°
A
B
C1
C2
D1
D2
E
F1
F2
G
H1
H2
I
J1
J2
J3
J4
U?
ZONE ?
FAULT
SIGNIFICANT



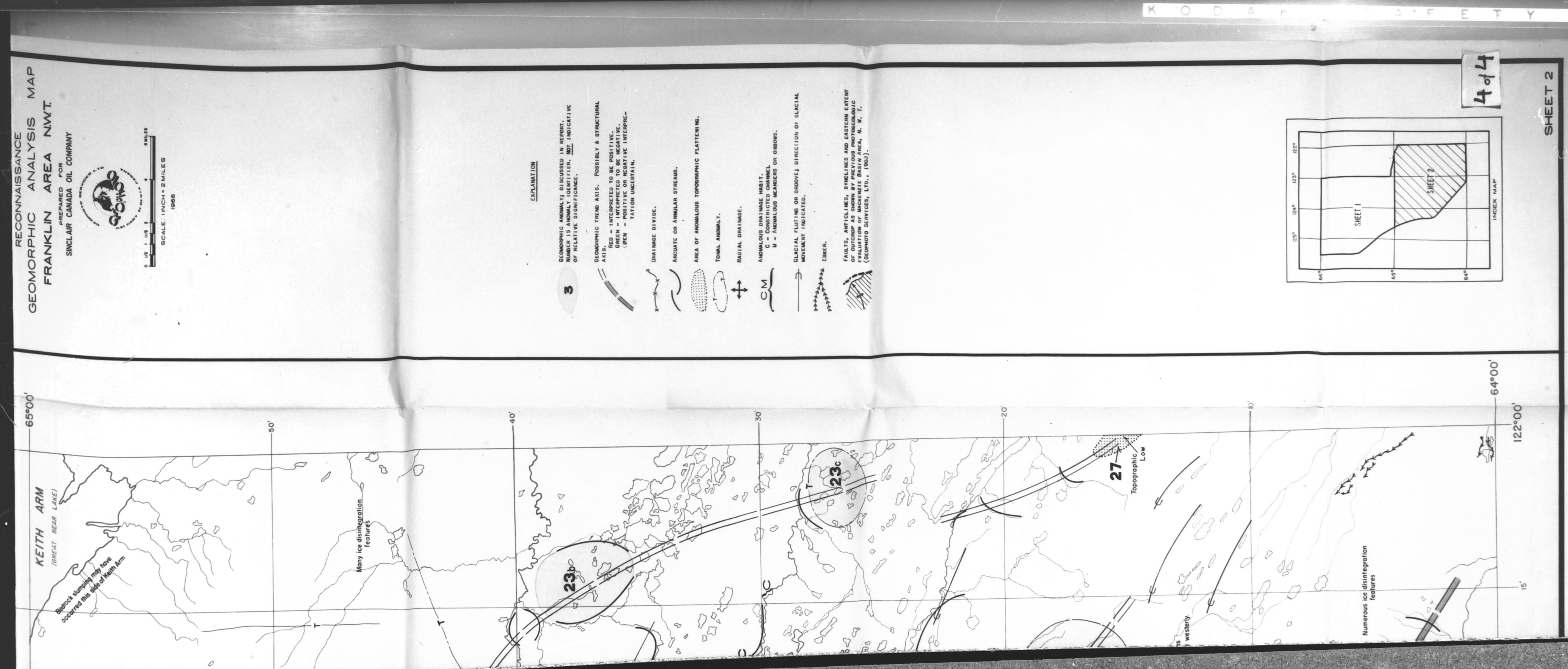
124°
123°
122°
85°
D3
ZONE OF SIGNIFICANT SUBSURFACE CHANGE?
K1
K2
K3
N
M1
L
O
M2
X
R
P
Q
T
SIGNIFICANT BASEMENT FAULT?
U?
O
M3
S
P2
M4
U
W
V
84°

INDIAN VILLAGE
KEELE RIVER
BURNT PT.
ABANDONED CAMP
SALINE RIVER
REDSTONE RIVER
RIVER
BIRCH ISLAND
MT. CLARK 4798
RANGE
FAULT
ZONE
BLACKWATER LAKE
24a
24b
25d
25e
25f
26
27
Topographic Low
Topographic High
Glacial grooves appear deflected westerly
Numerous ice disintegration features
Numerous ice disintegration features
20'
10'
64°00'
125°00'
45'
30'
15'
124°00'
45'
30'
15'
123°00'
45'
30'
15'
122°00'

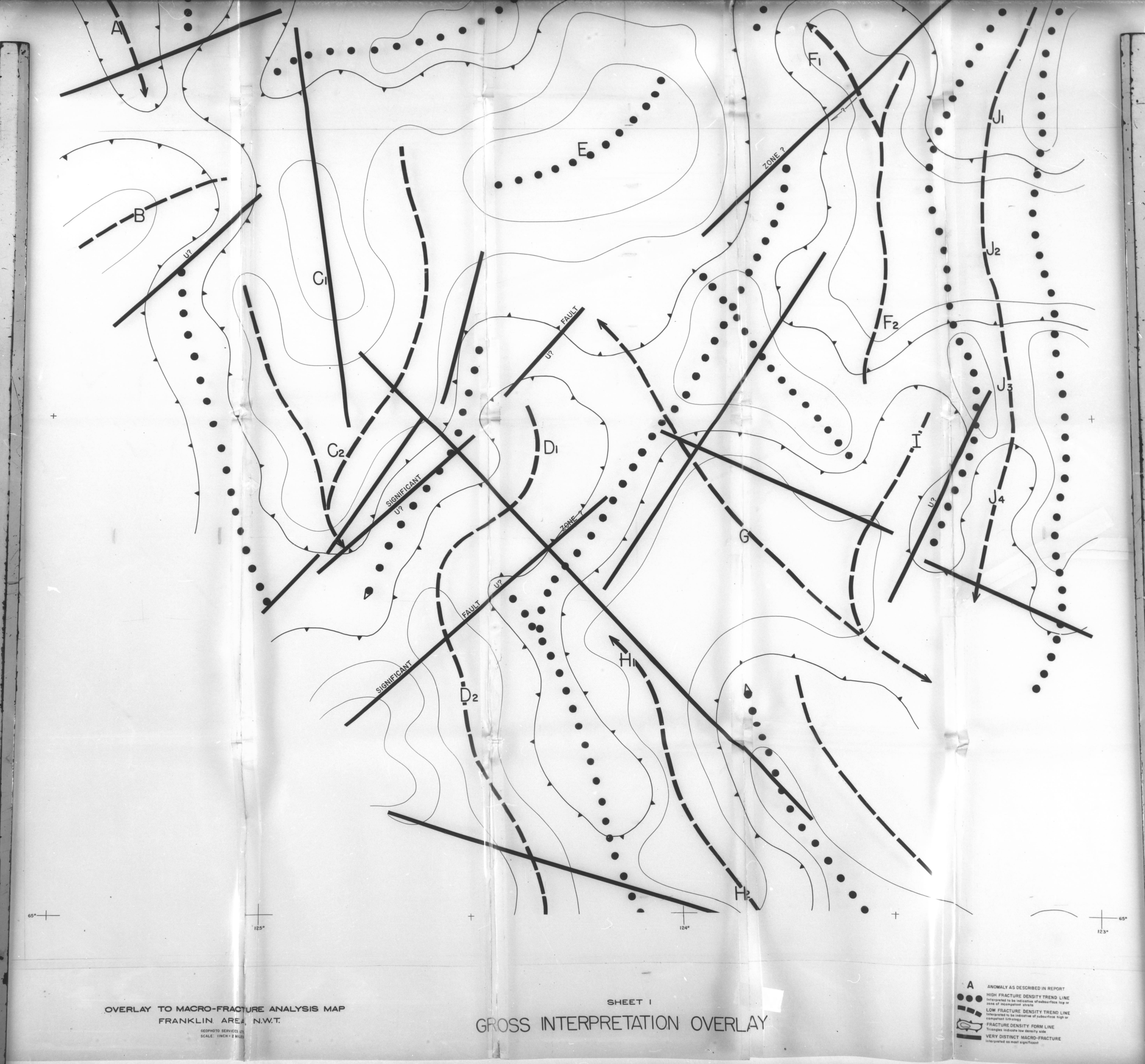
3 of



10'
BIRCH ISLAND
REDSTONE
BLACKWATER
LAKE
25e
Topographic High
25f
Numerous ice disintegration features
Numerous ice disintegration features
64°00'
125°00'
45'
30'
15'
124°00'
45'
30'
15'
123°00'
45'
30'
15'



RECONNAISSANCE
GEOMORPHIC ANALYSIS MAP
FRANKLIN AREA N.W.T.
PREPARED FOR
SINCLAIR CANADA OIL COMPANY
1966
EXPLANATION
4 of 4
SHEET 2
SHEET 1
SHEET 2
INDEX MAP
65°00'
KEITH ARM
(GREAT BEAR LAKE)
Many ice disintegration features
23b
23c
27
Topographic Low
Numerous ice disintegration features
64°00'
122°00'



OVERLAY TO MACRO-FRACTURE ANALYSIS MAP

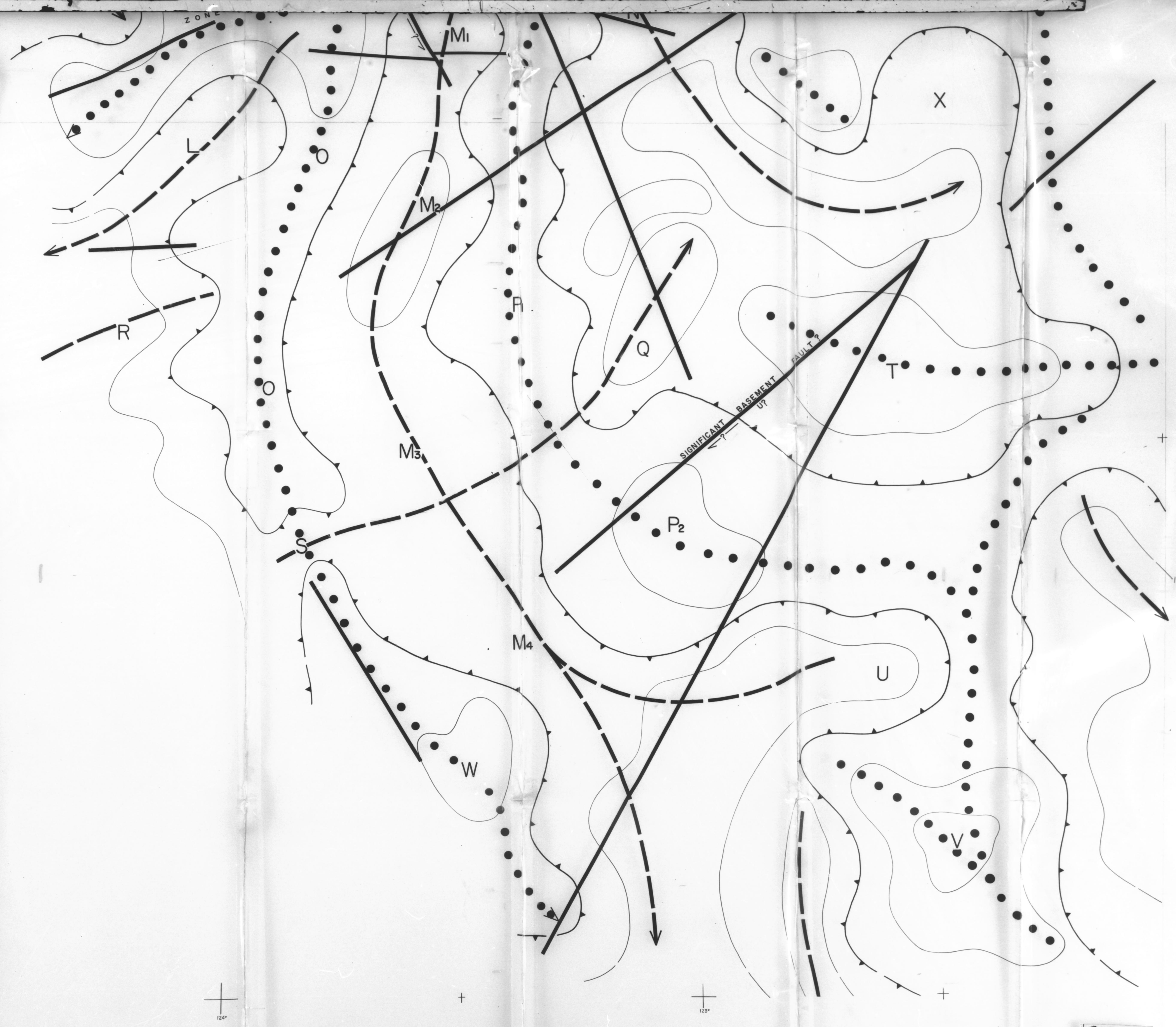
FRANKLIN AREA, N.W.T.

GEOPHOTO SERVICES LTD

SCALE: 1 INCH = 2 MILES

SHEET 1

GROSS INTERPRETATION OVERLAY



TIGHT BINDING

A ANOMALY AS DESCRIBED IN REPORT

HIGH FRACTURE DENSITY TREND LINE
Interpreted to be indicative of zone of subsurface change

LOW FRACTURE DENSITY TREND LINE
Interpreted to be indicative of subsurface high, low or competant lithology

FRACTURE DENSITY FORM LINE
Triangles indicate low density side

VERY DISTINCT MACRO-FRACTURE
Interpreted as most significant

OVERLAY TO MACRO-FRACTURE ANALYSIS MAP
FRANKLIN AREA, N.W.T.

GEOPHOTO SERVICES LTD.
SCALE 1 INCH : 2 MILES

SHEET 2

GROSS INTERPRETATION OVERLAY

2 of 2