GEO

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Report on the Creation & Analysis of a Multi-source Database in the Definition of Favorable Zones for Mineral Exploration

Kirkland Lake Area, Ontario

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SUMMARY

The main objective of this project was to create a digital spatial database containing multi-spectral (satellite) and geophysical (digital, raster) data. The Casan claim area falls within the database, which covers the Gauthier Township and vicinity. The larger extent of the database allows for the definition of larger structures (e.g., lineaments) conceivably intersecting the claims, however difficult to trace within a small area. All layers in the database were geo-referenced to the UTM (zone 17) grid system.

The analysis of the database consisted of the definition of lineaments possibly representative of faults or shear zones in the area. Subsequent field VLF survey can be conducted to verify the presence of conductors.

Finally, exploration targets were defined on the basis of multi-spectral (satellite, radar data) and geophysical parameters. Properties of known mines and ore bodies in the study area were determined and used as a selection criteria for favourable mineralization areas. This approach defines exploration targets on the basis of classification of multi-source data.

The understanding of spatial relationships between identified lineaments and exploration targets enables a more complete understanding of the mineralization process in the area of interest and will enable a design of a more efficient field exploration program in the future.

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1.0 THE CLAIM GROUP

The Gauthier Township Claim Group consists of 18 mining claims numbered:

L440934 to L440945 (12) *L482773 to L482778 (6)*

The claims were staked over a period of four years beginning in June of 1975 and ending in December of 1978.

Claim #	*Date Staked/Registered*
L440934	*June 2, 1975*
L440935	*June 2, 1975*
L440936	*July 11, 1975*
L440937	*July 11, 1975*
L440938	*July 11, 1975*
L440939	*July 11, 1975*
L440940	*July 11, 1975*
L440941	*July 11, 1975*
L440942	*July 11, 1975*
L440943	*July 11, 1975*
L440944	*July 17, 1975*
L440945	*July 17, 1975*
L482773	*Sept 20, 1976*
L482774	*Sept 20, 1976*
L482775	*Sept 20, 1976*
L482776	*Sept 20, 1976*
L482777	*Sept 20, 1976*
L482778	*Sept 20, 1976*

The claims were staked and recorded by George L. Roberts, Prospectors License #A42759, for Casan Mining Limited, Prospectors License #T805. The claims were staked to cover the majority of the old "Northland Gold Mines Limited" property. Additional claims north of the Northland property were staked to cover geophysical anomalies.

Casan Mining Limited completed extensive exploration from 1975 to 1983 on various portions of the claim group. In December of 1986, the 18 claims were surveyed and converted to a mining lease. The lease began May 1, 1987, effective for 21 years to April 30, 2008. The lease area is described as follows:

"All that parcel or tract of land and land under water in the Township of Gauthier, now in the Improvement District of Gauthier, in the Territorial District of Timiskaming and Province of Ontario, containing by admeasurement 737.35 acres, be the same more or less, being composed of that part of the said township, designated as Part 1 on a plan and field notes of Perimeter Survey CLM 311 deposited in the Land Registry Offices at Haileybury as Plan 54R-2881, comprising Mining claims L440934 to L44095, both inclusive, and L482773 to L482778, both inclusive.

SAVING AND EXCEPTING thereout and therefrom the surface rights only on and over a strip of land along the shore of unnamed beaver pond and which strip of land is bounded by the high water mark of the said pond and by a line every point of which is distant 400 feet from the nearest point in the said high water mark, containing 28.31 acres, be the same more or less."

1.1 LOCATION AND ACCESS

The claim group is located in Northern Ontario on the Western outskirts of Kirkland Lake. The location is shown in Figure 1. The claims are situated on N.T.S. 32DW - Larder Lake in Gauthier Township - Gauthier Improvement District inside the Mining Division of Kirkland Lake.

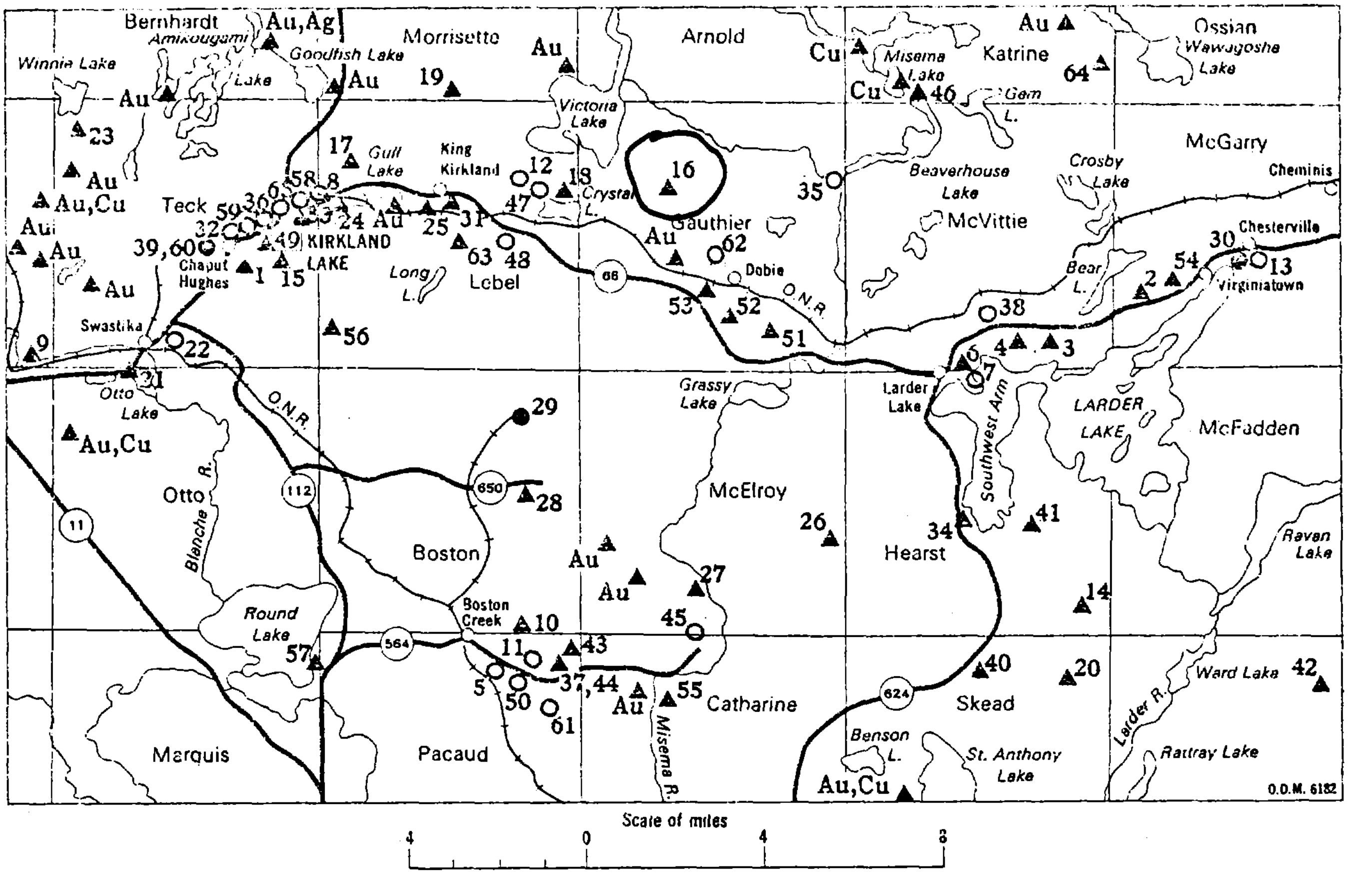
The approximate center of the claim group is located at: Latitude 48°10' North, and Longitude 79°50' West. A detail map is shown in Figure 2. The property is located at the north central part of Gauthier Township, one mile north of Dobie, tying onto the north of Upper Canada Mine. It extends northwesterly, with its northwest part adjoining to the northeast part of Crestland Mines Limited - formerly Northland Mines Limited.

1.2 TOPOGRAPHY

The property lies on relatively low ground, with average heights ranging from 1000 to 1150 feet AMSL. The western edge of the claim lies along two swampy-beaver dammed lakes/ponds. Drainage across the property runs east to Little Larder Lake or directly north to Victoria Creek. Numerous logging roads have been made from bulldozing the sand eskers that appear across the property. Most of the claims are covered in scrub/cut over areas, although there are some significant stands of mixed hardwoods and softwoods in the southern and western claims.

FIGURE 1.

PROPERTIES, PAST AND PRESENT PRODUCERS, MINERAL OCCURRENCES

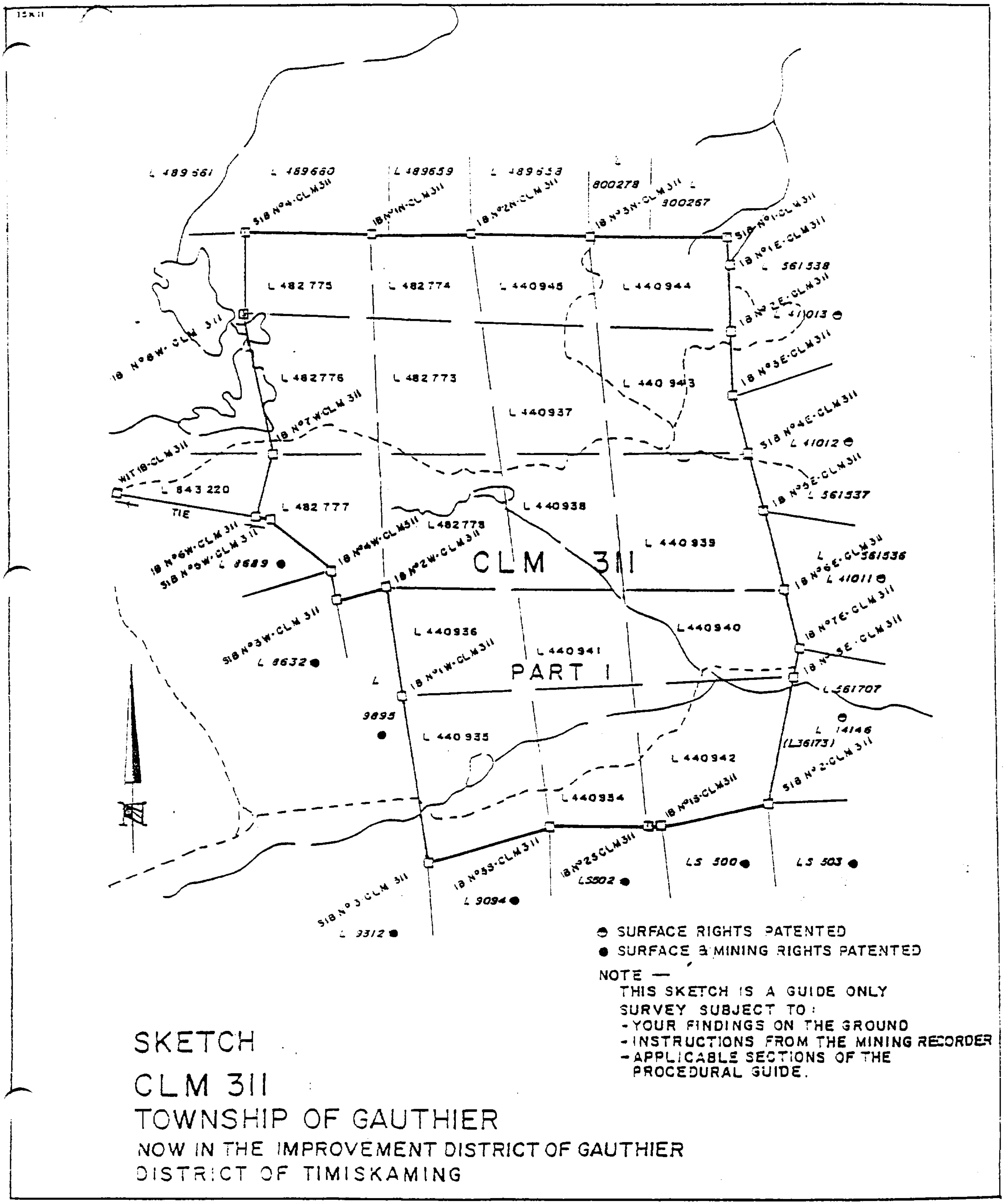


- ▲ Occurrence
- ● Producer
- ○ Past Producer

Ag – Silver Pb – Lead
Au – Gold U – Uranium
Cu – Copper Zn – Zinc
Fe – Iron

1. Amalgamated Kirkland Mines .... Au
Amalgamated Larder Mines
2. Barber-Larder occurrence ...... Au
3. Cheminis occurrence .... Au
4. Fernland occurrence .... Au
5. Amity mine .... Cu
Argosy Mining Corp.
6. New Laguerre occurrence ...... Au
7. Raven River mine .... Au
8. Associated Arcadia Nickel Corp. (Toburn mine) .... Au
9. Baldwin Consolidated Mines ..... Au
10. Bargnesi Mines .... Cu,Au
11. Barry-Hollinger mine .... Au
12. Biucop Mines (Bidgood mine) .... Au
13. Chesterville Mines .... Au
14. Combined Larder Mines, The .... Au
15. Consolidated Canorama Explorations (Hudson-Rand) .... Au
16. Consolidated Northland Mines ... Au
17. Continental Kirkland Mines ...... Au
18. Crystal Kirkland (Max Kaplan) . U,Au
19. Dolsan Mines (Mallard Lake) .... Pb,Ag,Cu
20. Fabis (LaFond) occurrence .... Au
Gateford Mines
21. Crescent occurrence .... Au
22. Golden Gate mine .... Au
23. Gauthier (Winnie Lake) .... Cu,Zn
24. Glenora (Albert Kokotow) .... Au
25. Harrison (Kirkrovale) .... Au
26. Hearst-Larder (Detfield Lowe and Emil Chorzepa) Zn,Pb,Cu
27. Hennesey occurrence .... Au
28. Jalore Mining Co. .... Fe,Pb,Zn
29. The Adams Mine .... Fe
30. Kerr Addison Mines .... Au
31. King Kirkland Gold Mines .... Au
32. Kirkland Minerals Corp. (Kirkland Lake gold mine) .... Au
33. Kirkland Townsite Gold Mines ... Au
34. Koroia-Larder Mines .... Au
35. Upper Beaver Mine (Argonaut) (Lake Beaverhouse) .... Cu,Au
36. Lake Shore Mines .... Au
37. Lebon Gold Mines .... Au
38. Lomega (Omega) mine .... Au
39. Macassa Gold Mines .... Au
40. Manor occurrence .... Au
41. Martin-Bird Gold Mines .... Au
42. Mathias occurrence .... Cu
43. Miller occurrence .... Au
44. Miller Independence .... Au
45. Mirado Nickel Mines (Cathroy mine) .... Au
46. Misema Lake Mining Corp. (Forwood) .... Au,Cu
47. Moffat-Hall mine .... Au
48. Morris-Kirkland Gold Mines ..... Au
49. Northgate Exploration (Kirkland-Hudson Bay) .... Au
50. Patterson mine .... Cu
51. Princeton Gold Mines (Ritoria mine) .... Au
52. Queenston Gold Mines .... Au
53. Queenston Gold Mines (Anoki mine) .... Au
54. Rio Algom Mines (Armistice) .... Au
55. Riverton Gold Mines (Gold Hill) . Au
56. Shelp (Dane Copper) .... Cu
57. Sheroomac Mining Corp. (Round Lake cooper) .... Cu,Zn
58. Sylvanite gold mine .... Au
59. Teck Corporation (Teck-Hughes mine) .... Au
60. Tegren Goldfields .... Au
61. Trethewey-Ossian mine (Mrs. Claire Cameron) .... Cu
62. Upper Canada Mines .... Au
63. Upper Canada Mines (Pawnee-Kirkland) .... Au
64. Wadge Mines (Walsh Katrine) ..... Cu
65. Wright-Hargreaves Mine .... Au

FIGURE 2 - Detailed Location Map



Most of the area covered by the claims involved is covered with glacial sand overburden to depths of up to 150'. Few areas have rock exposed on or near the surface, which have made mapping and sampling difficult. Many swamps and a few creeks are present. Sand eskers rising to 100' are common.

1.3 GEOLOGICAL SETTING

The north part of the property is mostly underlain by Keewatin acid volcanics, and the central part is underlain by Timiskaming sediments with two narrow zones of interbanded acid volcanics. The southwest part of the property is underlain by Algoman syenite and porphyry syenite - including the sediments.

The volcanics and sediments are steeply dipping and, apparently schistosed to various degrees. The contacts between the various rock formations are all covered by overburden.

1.4 PREVIOUS WORK

Casan has not engaged in work since 1983 on these claims, but detailed work has been completed upon the claims from 1976 to 1983. A detailed work history follows:

In the winter of 1976-77, the company conducted a program of geophysical surveys on this 18-claim group. The surveys were carried out by CANA Exploration Consultants Limited, and the results were described by Dr. S.S. Szetu in a report dated January 20, 1977. Readers are referred to this report for the geophysical data and also to the history of the property.

It should be noted here that the airborne E.M. anomaly referred to in said report was conducted by Upper Canada Mines Ltd., apparently prior to May, 1966, and the ground follow-up E.M. surveys were conducted in March and May of 1966 by Moreau Woodward and Company Limited of toronto. While the first survey failed, the second survey succeeded in detecting a conductor zone at an inferred depth of over 210 feet on the ground, held under option by Upper Canada Mines. The conductor zone opens to the west to a patented claim then held by Northland Mines.

Data in the office of the Resident Geologist at Kirkland Lake also showed one hole drilled in 1966, on the (then) Taylor Option, logged by J.G. Bragg, Chief Geologist, Upper Canada Mines. This hole was located at the central part of (then) Claim #79866 across the eastern section of the airborne E.M. anomaly which showed stronger conduction to the west. The hole cut a narrow band of graphite sediments with occasional bands and nodules of pyrite at a considerable depth.

Another hole was drilled to a shallow depth of 148.6' at a location further east by the (then) owner of the property, Mr. T.C. Taylor, for assessment work purposes. According to Mr. Taylor, the drill site found near L28N - 1450'E, was the set-up for this shallow hole.

During the month of June, 1978, the Company (Casan Mining Limited) conducted two programs - a geological survey and a radiometric survey, on this 18-claim group. The surveys were carried out by CANA Exploration Consultants Limited under the direction of Dr. S.S. Szetu, and the results are described by the author, Dr. S.S. Szetu, in his reports dated July 29, 1978 and August 21, 1978.

The geological report produced for Casan Mining Limited by CANA Exploration Consultants Limited and written by Dr. S.S. Szetu, dated July 29, 1978, requested that detailed surface sampling of the claims held by this company be carried out before and drilling exploration be undertaken.

Casan Mining Limited contracted with Dynamic Construction Ltd. of Toronto to undertake the excavation of trenches and surface blasting, trenching, and drilling that would allow detailed sampling of the rock areas available for exploration. This work was carried out in 1978 and submitted in our report dated December 10, 1978.

A thorough geochemical survey was undertaken and completed in 1980, and the results demonstrated an extremely strong relation-ship and correlation between the geochemical and E.M. anomalies already defined. The results and map produced can be found in our report dated October 20, 1980.

Casan Mining contracted Dynamic Construction of Toronto to drill selected anomalic areas in

1980 and 1981. The results of each drilling program are expressed in their corresponding reports dated October 29, 1980 and October 25, 1981. A preliminary summary of gold discoveries on the claims is included below:

Preliminary Summary of Gold Values on Casan Property (from literature search):

DATE	***PROGRAM***	***SAMPLE***	***Au VALUE (oz/ton)***
1966	*Upper Canada mines*	*DDH66-1 (197.3'-198.0')*	*0.01*
	(Taylor Option)	*DDH66-1 (437.5'-440.0')*	*0.02*
		DDH66-1 (517.0'-518.0')	*0.03*
1975	*Dr. S. Szetu*	*grab sample @ #2 shaft*	*0.03*
	(during staking)		
1978	*Casan - trenching*	*Sample #44 (Pit D)*	*0.015*
		Sample #45 (Pit D)	*0.018*
		Sample #2799 (Pit J)	*0.04*
		Sample #6 (Pit N)	*0.02*
		Sample #200 (Pit N)	*0.02*
		Sample #3 (Pit N)	*0.008*
1981	*Casan - drilling*	*DDH81-1 (No.202)*	*0.01*

2.0 ANALYSIS PROCEDURES

Three broad groups of digital image analysis procedures were selected as applicable to this project:

1) *Lineament extraction used for structural analysis*
2) *Tonal enhancements complementing lithological mapping*
3) *Signature search using tonal enhancements to define areas of similar spectral characteristics to known outcrops*

The significance of these procedures lies in improved definitions of surface expressions of morphological and tonal features potentially pertinent to geological structures, lithological units, their alterations and exploration targets.

2.1 LINEAMENT ANALYSIS, OVERVIEW

The approaches to detecting linear terrain features in satellite imagery have generally involved the isolation of local line segments. The decision as to whether an image pixel belongs to a linear feature is based on the output of an arithmetic function applied to the value of that pixel and values of its immediate neighbourhood. The output is then compared to a specified threshold value. VanderBrug (1976) defined the rectangular neighbourhood array and the detection function as the local detector. Three basic detectors (linear, non-linear and semi-linear) were used to determine whether a given pixel is a part of the line. Gurney (1980)modified the semi-linear detector to allow shorter computation time when detecting lines in a variety of directions.

The threshold, T, used in a local detector should give a suitable balance between detecting noise and failing to detect linear features. However, detected radiance may vary considerably due to topographic, atmospheric and cover material variations as well as sensor imperfections (Lillesand and Kiefer, 1979). Thus, the threshold should be adjusted according to the degree of *correlation between line and background pixels (Gurney, 1980). This project employs a technique which uses different sizes for local detectors.*

A shape classification using a tree grammar approach (Li and Fu, 1976) was used to classify rivers and highways on LANDSAT imagery. In principle, the classification is carried out by finding a linear feature and tracing it until its ends are found and the representative tree is constructed. The tree may include nodes, lines or edges and is compared to predetermined sample patterns. Results of obtained classification tests show confusion between highways and local streets, possibly due to the selection of test samples and grammar inference procedure.

Edge detection using a high-pass filter is described by various authors (Gonzales and Wintz, 1978; Gillespie, 1980). High-pass filtering and histogram equalization are the main techniques used in this procedure. Spatial filtering of principal components is a generalized approach described by Robinson (1977). Edge detection is performed in transformed coordinate system with a lower signal-to-noise ratio (Appendix B). Combined edge and line enhancement using nine dimensional orthogonal vectors (Frei and Chen, 1977) produced wide and "noisy" lineaments and extensive scaling is documented as necessary. The detection of lines in a variety of directions can be achieved by reconfiguring the window array or using different detector elements for each direction, the method used in this thesis.

It should be noted that lineament recognition is a problem that has not yet been generally solved. Lineaments are not simply straight lines on a natural image, but a re usually inferred from discontinuous zones of small segments with varying gradient and brightness values. Line and curve tracking algorithms are of limited value to the geologist who is more interested in locating the actual line segments which may represent the surface expression of the structure.

2.2 *GEOLOGICAL LINEAMENTS*

The recognition and location of faults and shear zones in densely vegetated or poorly exposed areas is a slow and painstaking process. The necessary knowledge of local stratigraphy, structural framework and tectonic conditions takes a long time to acquire. The synoptic view of satellite imagery and airborne geophysics can replace this process by enabling the definition of regional image gradients as abrupt changes in brightness aligned along a recognizable curvilinear edge - possibly indicative of faults or shear zones.

Definitions proposed by O'Leary et al. (1976) state that:

> *Lineament refers to a "mappable, single or composite linear feature of a surface whose parts are aligned in a rectilinear or slightly curvilinear relationship, and which differs distinctly from the pattern of adjacent features and presumably reflects a subsurface phenomenon".*
>
> *Linear is an "adjective, that describes the line-like character of some object or objects".*
>
> *Curvilinear is a term added by the author to distinguish a round-shaped, contiguous linear feature.*

Faults appear on remote sensing images as lineaments (gradients, linear features) as a result of contrasting:

- *topography*
- *rock type*
- *tonal character*
- *fracture and fold characteristics*
- *weathering and erosion characteristics within a fault zone*

Various procedures described in literature were previously tested using digital image analysis procedures of LANDSAT MSS and TM data by the authors applied to structural interpretation (e.g., Lodin and Torrance, 1988, etc.).

The following section describes a procedure designed by the authors and tested on various sites with ongoing geological investigations (Lodin, 1988, 1989).

3.0 DATA SPECIFICATIONS

3.1 SATELLITE IMAGERY

Two LANDSAT TM (Thematic Mapper) images were purchased for this project. Seven spectral bands from the electromagnetic spectrum (Plate 1,2) cover an area of approximately 60x60 km (i.e., 1 quarter scene). Data acquired on May 17, 1989 and September 6, 1989 were chosen for the project given the seasonal vegetation response and a relatively up-to-date land use/cover information. The relationship between vegetation and underlying bedrock falls within the field of geobotany.

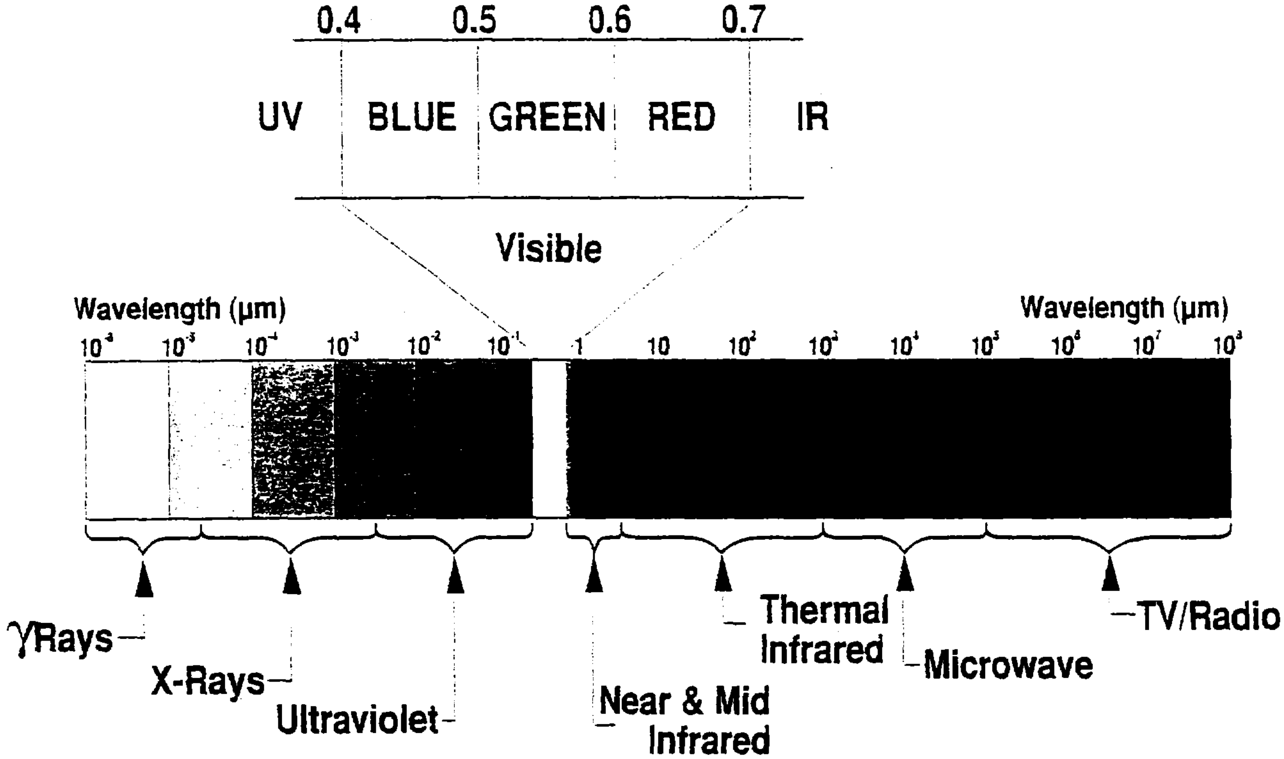
3.2 GEOBOTANY

In Canada, extensive vegetation, snow and ice cover hinder determining the relationship between surface and subsurface phenomena. In most geological studies, vegetation cover is considered a hindrance. However, geobotany in fact can aid geological mapping.

Geobotany is generally defined as the visual survey of vegetation in order to describe geological differences in landscape (Raines and Canney, 1980). It is difficult to generalize the precise inter-relationships between bedrock, soil and vegetation due to the variety of local conditions. The basic premise assumes a relationship between soil and the underlying bedrock. It can be chemical (interchange of micronutrients, moisture, etc.) or morphological (the effect on slope due t bedrock structures and/or differential erosion). Convincing results are described in the detection of limestone soils, ultramafic shallow bedrock, and sulphide accumulations (Hawkes and Webb, 1976).

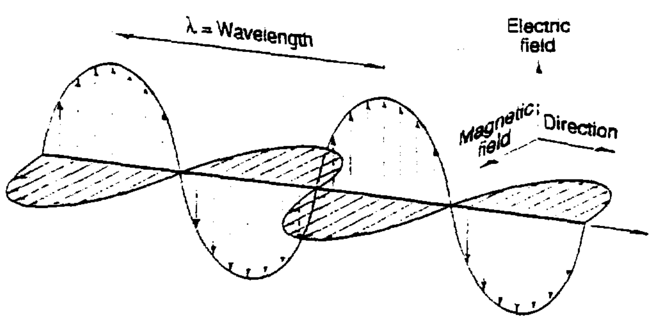
Spectral reflectance from green vegetation is low in the blue and red region of the spectrum, higher in the green region, and highest in the near infrared (Fig.3). Chlorophyll has a great capacity to reflect infrared radiation, which rapidly diminishes with poor plant health caused by

THE ELECTROMAGNETIC SPECTRUM



The electromagnetic spectrum is a continuum of all electromagnetic waves arranged according to frequency and wavelength. Electromagnetic energy travels through space in waves at 299,792.458 km per second, the speed of light. Wavelength is the distance from wavecrest to wavecrest. Frequency is the number of wavecrests passing a given point per second.

The spectrum is divided into regions based on wavelength ranging from short gamma rays, which may have wavelengths of 10^{-6} µm or less, to long radio waves which have wavelengths of many kilometers.



Because the range of electromagnetic wavelengths is so vast, the wavelengths are often shown graphically on a logarithmic scale.

Visible light is composed of wavelengths ranging from 0.4 (blue) to 0.7 (red) µm. This narrow portion of the spectrum is the entire range of electromagnetic energy to which the human eye is sensitive. Landsat TM sensors collect data from the blue (Band 1--.45 to .52 µm), green (Band 2--.52 to .60 µm), and red (Band 3--.63 to .69 µm) regions of the visible spectrum.

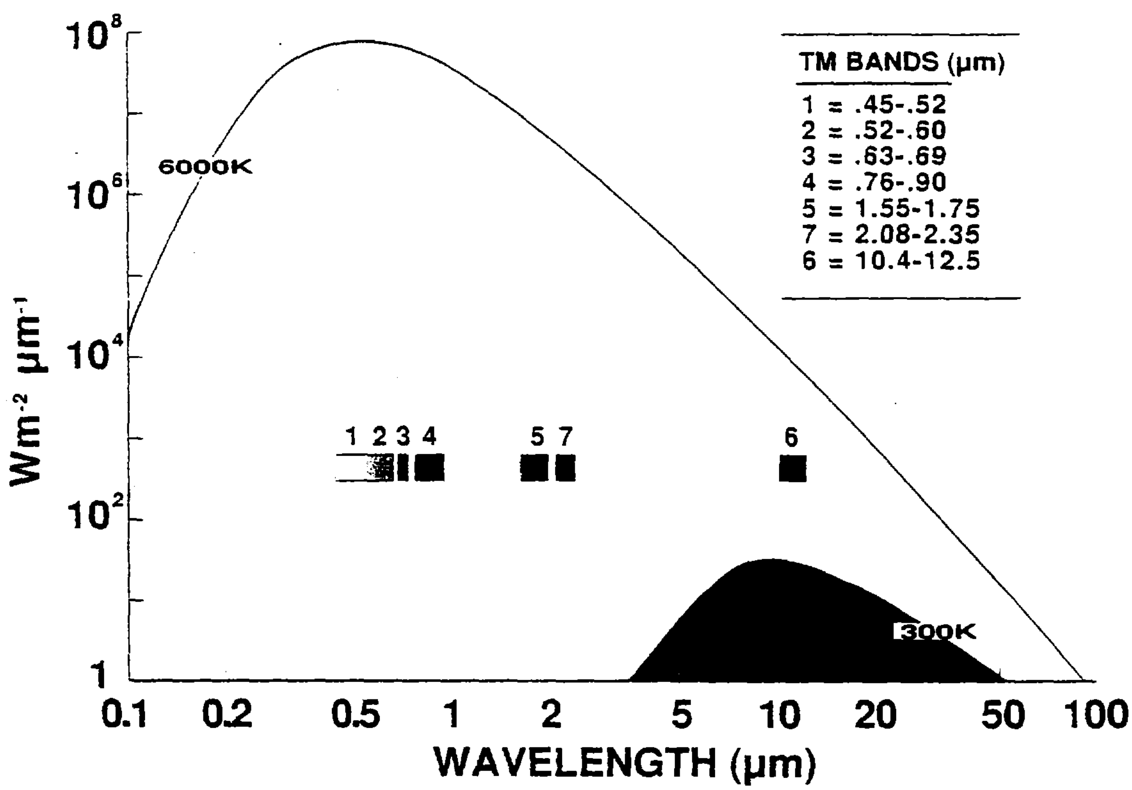
Just beyond the red end of the visible bands are three regions of infrared energy waves. Landsat TM sensors collect data from the near-infrared (Band 4 -- .76 to .90 µm), the mid-infrared (Band 5--1.55 to 1.75 µm: Band 7--2.08 to 2.35 µm), and the thermal infrared (Band 6--10.4 to 12.5 µm) regions.

TM Bands 1, 2, 3, 4, 5, and 7 measure reflected energy. TM Band 6, the thermal band, measures emitted energy.

Plate 1

LANDSAT THEMATIC MAPPER BANDS

Adapted from *Remote Sensing and Image Interpretation*. Lillesand and Kiefer. Reprinted with permission. copyright © 1987 by John Wiley and Sons. Inc.



This figure illustrates two laws of physics which are fundamental to remote sensing -- the Stefan-Boltzmann Law and Wien's Displacement Law. Both laws are based upon Planck's equation for emitted radiation.

The Stefan-Boltzmann Law states that the hotter an object is, the greater total energy that object emits. The area under the curve for the sun (at 6000K) is much greater than the area under the curve for the Earth (at 300K).

Wien's Displacement Law says that as an object gets hotter, its peak emission is at a shorter wavelength. The peak emission for the sun is at .5 µm; the peak emission for the earth is at 9.5 µm. Unusually hot objects (forest fires, lava flows, and emissions from smoke stacks) have emission peaks that fall between .5 µm and 9.5 µm and thus can be detected in TM Bands 5 and 7. Band 6 is designed to measure surface temperatures (from approximately -100°C to +150°C), but Bands 5 and 7 are more useful than Band 6 for pinpointing small, hot targets because of their greater spatial resolution (30 meters compared to 120 meters for Band 6). In addition, the high transmittance of the mid-infrared wavelengths means that Bands 5 and 7 penetrate smoke that obscures forest fires in Bands 1, 2, and 3.

The wavelength ranges of the TM bands are superimposed on the figure above to show how these bands relate to the energy peaks of the Earth and sun.

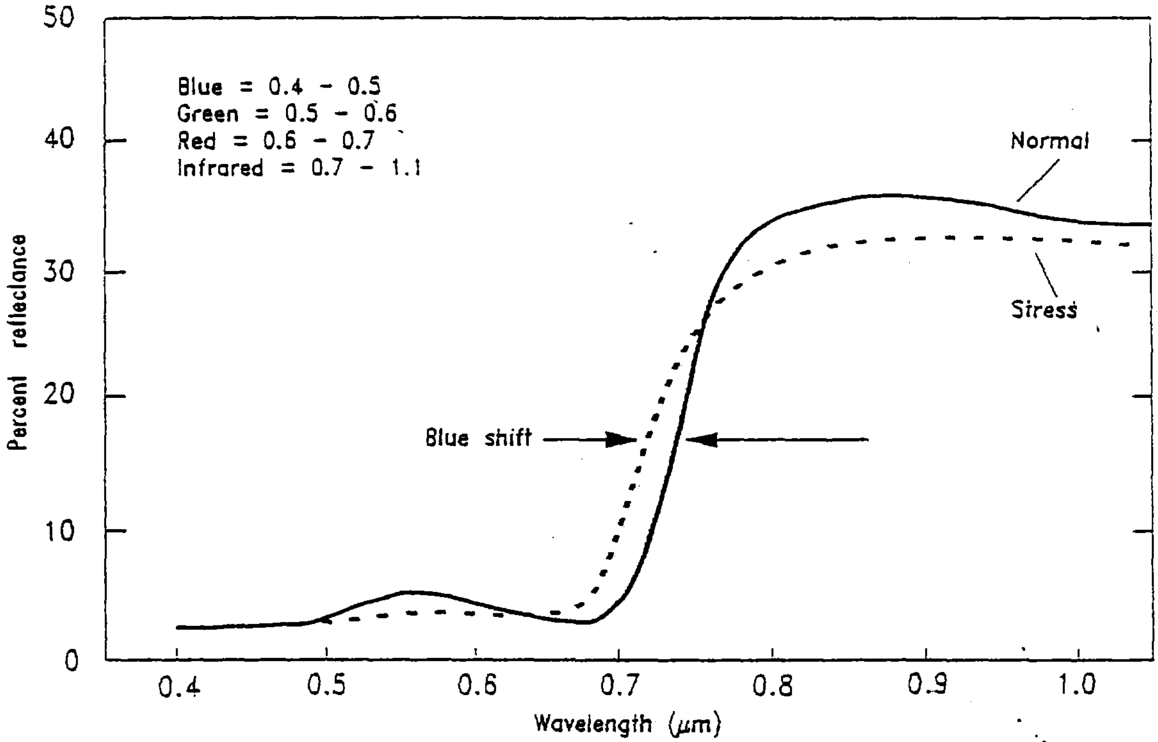


Figure 3: Spectral Plot of Healthy vs. Stressed Green Leaves,
From Reid (1988).

various factors, e.g., anomalous accumulations of metals. Plants respond to accumulations of metallic minerals by undergoing physiological and morphological changes that result in alteration of their outward appearance. This is detected in the more sensitive infrared region as subtle reflectance changes. These depend on cellular structure, water content, pigment change, and so on.

3.3 GEOPHYSICAL DATA

The total of eight data layers was purchased from the Geological Survey of Canada. The unprocessed, raster (pixel format) data was acquired at 500 m pixel size, scaled within the relative, displayable range of 0-255 (Table 1). All files were overlayed with satellite imagery and used for subsequent correlation with lineaments and exploration target definition.

3.4 RADAR DATA

Radar C-band data was acquired in raster format (12 m resolution) centered at approximately 48°10' and 79°50'. The data was not enhanced in any way (e.g. radiometric balancing or geometric correction). All subsequent processing was facilitated on GEODAT's digital image analysis system.

TABLE I LIST OF ACQUIRED GEOPHYSICAL DATA IN RASTER FORMAT

[illegible] 1978, [illegible]

[illegible] 233 [illegible] 126 pixels per scan.

[illegible] 500.[illegible] [illegible] 500.[illegible] ... pixel size

The map [illegible] used for this data set was [illegible]

[illegible] corner of scan and column [illegible]

[illegible] (northing and easting metres).

Scan 1 pixel 1 has been set to [illegible] intensity
Scan 1 pixel 126 has been set to [illegible] intensity
Scan 233 pixel 1 has been set to [illegible] intensity
Scan 233 pixel 126 has been set to [illegible] intensity

[illegible] 81.00000

Data grid compiled: 1990.12 [illegible] 07 [illegible]

[illegible] record length = 126 bytes.

Tape BLOCK length = 126 bytes (may be padded to even number)

Typical script for PCI tape input session. The values used are taken [illegible] current data set and assume the first image on the tape.

[illegible]	General [illegible] Tape to Database Transfer (EASI/PACE v5.2)			X:	Y:	
	- Database File Name	[illegible]				
MTIW	- Mag Tape Input Window	;	1	1	126	233
	- Database Output Window	;				
MTID	- Mag Tape Identification	;				
	- Database Output Channel List	;	1 ([illegible])			
RECL	- Record length for General [illegible] Ta	;	126			
	[illegible] of scan lines per record	;	1			
[illegible]	- Number of records to skip	;	0			
	[illegible] Number	;	1 (i.e. file no.)			

[illegible]	[illegible] Converted to PCI	Extrema used for Conversion Minimum	Extrema used for Conversion Maximum	Data type
	[illegible]_GRID_TRUE_EXP.TBD	[illegible]	[illegible]	total exposure
2	SKYSURVEY_GRID_TRUE_[illegible].TBD	[illegible].014	[illegible].4[illegible]	total K
	[illegible]_GRID_TRUE_URA.TBD	[illegible]	[illegible]	total U
4	SKYSURVEY_GRID_TRUE_THO.TBD	[illegible]	[illegible]	total Th
	[illegible]_GRID_TRUE_[illegible].TBD	[illegible]	[illegible]	U/Th
6	SKYSURVEY_GRID_TRUE_[illegible].TBD	.000	[illegible]	U/K
	[illegible]_GRID_TRUE_[illegible].TBD	[illegible]	[illegible]	Th/K
8	SKYSURVEY_GRID_TRUE_MAG.TBD	55950.000	63400.00[illegible]	total field aeromagnetics

4.0 DATA PROCESSING

4.1 GEOMETRIC CORRECTIONS

Due to the earth's curvature, rotation, as well as satellite and orbit characteristics, satellite imagery is not directly compatible with a map. Geometric errors of the scanner are caused by variable mirror sweep, velocity, panoramic distortions, and changes in attitude and altitude of the satellite (Bernstein and Ferneyhough, 1975). Some of these errors are corrected by modelling and calibration and others require user's participation.

The image can be registered to the selected map base using points defined on both the map and image (ground control points - Appendix 1). A polynomial function is computed and the image transformed to fit the map. The distribution of ground control points is one of the factors controlling the accuracy of transformation. The "Stable", well identifiable ground control points include road or railway intersections, bridges and other man-made point features usually, best defined in the red portion of the visible spectrum (LANDSAT TM band 3). Additional points can be defined from the infrared spectral bands sensitive to water content (lakes, river intersections, etc.) Due to temporal changes, these points are not considered stable (their location at the time of image acquisition may differ from the position shown by the map).

The polynomial transform function used has the form:

XC = AO + A1*X1 + A2*Y1 +A3*X1*2 +A4*Y1*X1 + A5*X1**2 +
A6*X1**3 + A7*X1**2*Y1 + A8*X1*Y1**2 + A9*Y1**3

YC = BO +B1*X1 + B2*Y1 + B3*X1*2 +B4*Y1*X1 + B5*X1**2 +
B6*X1**3 + B7*X1**2*Y1 + B8*X1*Y1**2 + B9*Y1**3

where:

XC, YC = master (map), X1, Y1 = slave (satellite image).

Precision comparable to a topographic base is, however, achievable only using imagery with narrow field-of-view and nadir pointing sensors. In addition, transformed geographical features must be of limited size and terrain relief must be minimal.

These conditions are not met when satellite imagery is used, and therefore most image analysis systems incorporate the calculation of line and pixel residuals as measures of transformation accuracy. Line and pixel residuals represent the "fit" (usually RMS error) of each GCP to the Polynomial Transform Function (appendix 1). However, this function is calculated from available Ground Control Points and is therefore dependent on their distribution, location accuracy and stability. It also reflects the relationship between the complexity of image distortion and order of the used polynomial.

Accuracy of geometric corrections of all data layers used in this project is listed in Appendix 1. Pixel size of 25 m, resampling by cubic convolution and 3rd order polynomial were used as standard for the created database.

4.2 EXPLORATION TARGETS DEFINITION

A computer-aided search for spectral and geophysical signatures of known mineralized zones was conducted using classification techniques of the digital image analysis system. The procedure uses test areas defined by a known mineral occurrence in a naturally vegetated environment *(clear cuts, forest burns, built-up areas are excluded from the search). Up to sixty images can be analyzed at the same time. Test areas are specified by mean and standard deviation of values within each image. Exploration targets presented on 1:12,000 plots represent areas favourable for subsequent field survey.*

5.0 RESULTS

5.1 LINEAMENT ANALYSIS

Six lineament directions of importance were identified for this project by the client. Each lineament direction was transferred from the raster-based digital image analysis system and transferred onto a topographic base, initially digitized as N.T.S., 1:50,000. Lineaments were extracted from LANDSAT band-5 (infrared) using 3x3 size filter in NW, NS, NE, EW, ENE, AND ESE directions. The output plots at a scale of 1:12,000 enable correlations between mapped faults shown on published geological map (Map No. 50c, Thomson and Griffis, 1941).

The significance of faults in the mineralization process in the study area is substantial. Generally, the shearing strikes parallel to the rock formations (Thomson and Griffis, 1944). Typically, veins accompanied with narrow shear zones with rock alterations and mineralization strike to the north or northeast, roughly perpendicular to the major breaks. A major E-W fault reported next to the claim area was found on the 1000 foot level at No. 1 shaft (Northland Gold Mines), but not recognized on the surface. Wall rock mineralization is associated with this break, which strikes N.80°W. and dips steeply to the south. Thus, the detection of previously unmapped faults via field verification of defined lineament (e.g., by a VLF traverse) is of significance to further development of the property.

5.2 LINEAMENT CORRELATIONS

Correlations of defined lineaments over the claim area are shown at a scal of 1:2400. The offset between VLF conductors and lineaments is, in some cases, due to the resolution of input data (25 m) noticeable at the above scale. Good correlation between a VLF conductor and LANDSAT lineament was found for one NW trending lineament (claim #L440937). Extended NW lineament on claim #L482777 correlates with VLF as well. Radar NW lineament (claim #'s L440934/L440936) and an EW lineament (L440943/L440937) show good correspondence to VLF conductors. No correlation between lineaments and magnetic conductors was found.

5.3 EXPLORATION TARGET DEFINITION

Two groups of parameters were selected for the definition of targets:

1) *Selected spectral bands of two dates of LANDSAT imagery with radiometric data.*
2) *Selected spectral bands of two LANDSAT dates with aeromagnetic data.*

5.3.1 UPPER CANADA MINE TEST AREA

Statistical correlations for the Upper Canada and the Anoki test sites (photo-documented) are given in Appendix 5. Exploration targets within the claim area are shown on the attached maps.

No exploration targets on the claim area were found using the radiometric/LANDSAT group. Aeromagnetic and LANDSAT parameters identified target clusters in the southern portion of the claim group (claim #'s L440935, L440936) and directly north of this cluster (claim #L482773).

All defined target clusters lie in a roughly N-S swath one claim wide, and correlate with the presence of magnetic conductors. This corresponds to the inclusion of regional aeromagnetic data in the search parameters.

5.3.2 ANOKI MINE TEST AREA

Very good statistical correlations were obtained for the Anoki Mine area using LANDSAT and radiometric ratio data (Appendix 5). Defined exploration target cluster (claim #L440938) correlates spatially with a N-S LANDSAT lineament and a N-W VLF conductor. Relatively low standard deviation (sigma=3.5) indicates a good statistical reliability of this result.

6.0 REFERENCES

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APPENDIX 1

Documented accuracy of geometric corrections

gcprep

1;1HJ0;1;7mGCPREP 0m7mGround Control Point Segment Report 1m
01:48H EASI/PACE V4.3 0m7m21:25 11-FEB-910m

E:\TM89_CAS.PIX [S 7PIC 3504P 2944L] 25-JAN-91

2:cas_gcp Type:213 [Ground Control Points] Last Update: 16:20 29-JAN-91
Contents:
Set 2 Units:PIXEL Set 1 Units:PIXEL Number GCPs: 37

Model Parameters		FX	FY
1	CONS	.149704E+04	.475840E+03
2	X	.651891E+00	-.174183E+00
3	Y	.169358E+00	.972259E+00
4	X * Y	.365076E-04	.394614E-04
5	X**2	.289155E-04	.474948E-04
6	Y**2	.355258E-04	-.153705E-04
7	X**2 * Y	-.409776E-07	-.209703E-07
8	X * Y**2	.984360E-08	-.145410E-07
9	X**3	-.277713E-08	-.197364E-07
10	Y**3	-.222349E-07	.165666E-07

Residuals are numbered from worst to best.

GCP no.	GCP (Set 2 Units)		GCP (Set 1 Units)		Residual (Set 1 Units)		Distance
32	196.5	880.5	1790.5	1301.5	-3.637	-1.163	3.818
27	126.5	771.5	1728.5	1206.5	3.148	.920	3.280
37	586.5	909.5	2069.5	1278.5	2.623	1.009	2.810
8	789.5	165.5	2055.5	521.5	-2.519	.045	2.520
29	644.5	503.5	2025.5	869.5	.726	-2.318	2.429
6	659.5	300.5	1996.5	672.5	1.798	1.099	2.107
14	242.5	657.5	1782.5	1075.5	.058	-1.893	1.894

Press: [G]o; e[X]it; <cr> for next page:

15	453.5	583.5	1909.5	976.5	-1.620	.673	1.754
17	353.5	611.5	1850.5	1016.5	1.704	-.412	1.753
16	490.5	493.5	1916.5	883.5	-1.625	.616	1.738
33	740.5	1000.5	2187.5	1345.5	-1.589	-.291	1.616
10	179.5	567.5	1720.5	998.5	-1.495	-.121	1.500
25	315.5	527.5	1807.5	939.5	1.253	-.704	1.437
4	806.5	279.5	2092.5	630.5	1.336	-.475	1.418
13	308.5	796.5	1855.5	1205.5	.696	1.169	1.361
20	642.5	792.5	2080.5	1154.5	-1.194	-.271	1.225
21	863.5	765.5	2225.5	1096.5	-.428	-1.085	1.167
9	982.5	313.5	2219.5	639.5	1.006	-.541	1.143
11	819.5	522.5	2146.5	866.5	-1.125	-.089	1.128
24	153.5	690.5	1728.5	1123.5	.243	1.102	1.128
35	823.5	848.5	2216.5	1184.5	1.111	.011	1.111
3	346.5	423.5	1805.5	834.5	-1.065	.059	1.067
26	614.5	433.5	1990.5	808.5	.165	1.005	1.019
31	446.5	996.5	1987.5	1383.5	-.632	.790	1.012
2	100.5	477.5	1650.5	923.5	-.670	.694	.964
36	262.5	1014.5	1865.5	1425.5	.721	-.482	.867
22	990.5	625.5	2283.5	943.5	-.583	.638	.864
34	879.5	943.5	2272.5	1269.5	.813	-.072	.816
12	834.5	623.5	2177.5	963.5	-.475	.457	.659
7	588.5	178.5	1923.5	561.5	.654	.012	.654

Press: [G]o; e[X]it; <cr> for next page:

18	989.5	518.5	2262.5	839.5	-.014	.608	.608
23	470.5	700.5	1946.5	1088.5	.260	.538	.598
1	126.5	270.5	1629.5	717.5	.407	-.350	.537
30	420.5	852.5	1942.5	1243.5	.097	-.512	.521

```
 26(    12[illegible].5,     643.5)(   1598.5,    1060.5)(     -.25[illegible],      -.401)      [illegible]
 19(    650.5,     645.5)(   2057.5,    1009.5)(     -.011,      -.244)      .244
  5(    382.5,     252.5)(   1797.5,     662.5)(      .117,      -.023)      .119
Press:  [G]o;  e[X]it;  <cr> for next page:

 Residual plot (Set 1 Units):RMS=(     1.341,       .798), Distance=     1.561
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 :                   :                   :
 :                   :                   :
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 :                   2413     6          :
 :          15   31  26          37 27   :
 :                12 23                  :
 +-------8---10-3----+5-3435-------------+
 :          3320    30 1369 17           :
 :                   :    25             :
 :32              21 :                   :
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 :                  14                   :
 :                   :  29               :
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Set 2 Units:PIXEL   Set 1 Units:PIXEL   Num X:0658 Y:0571

Model Parameters		FX	FY
1	CONS	.149704E+04	.475840E+03
2	X	.651891E+00	-.174183E+00
3	Y	.169358E+00	.972259E+00
4	X * Y	.365076E-04	.394614E-04
5	X**2	.289155E-04	.474948E-04
6	Y**2	.355258E-04	-.153705E-04
7	X**2 * Y	-.409776E-07	-.209703E-07
8	X * Y**2	.984360E-08	-.145410E-07
9	X**3	-.277713E-08	-.197364E-07
10	Y**3	-.222349E-07	.165666E-07

Residuals are numbered from worst to best.

GCP no.	GCP (Set 2 Units)		GCP (Set 1 Units)		Residual (Set 1 Units)		Distance
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8(	789.5,	165.5)(	2055.5,	521.5)(	-2.519,	.045)	2.520
29(	644.5,	503.5)(	2025.5,	869.5)(	.726,	-2.318)	2.429
6(	659.5,	300.5)(	1996.5,	672.5)(	1.798,	1.099)	2.107
14(	242.5,	657.5)(	1782.5,	1075.5)(	.058,	-1.893)	1.894

Press: [G]o; e[X]it; <cr> for next page:

15(	453.5,	583.5)(	1909.5,	976.5)(	-1.620,	.673)	1.754
17(	353.5,	611.5)(	1850.5,	1016.5)(	1.704,	-.412)	1.753
16(	490.5,	493.5)(	1916.5,	883.5)(	-1.625,	.616)	1.738
33(	740.5,	1000.5)(	2187.5,	1345.5)(	-1.589,	-.291)	1.616
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25(	315.5,	527.5)(	1807.5,	939.5)(	1.253,	-.704)	1.437
4(	806.5,	279.5)(	2092.5,	630.5)(	1.336,	-.475)	1.418
13(	308.5,	796.5)(	1855.5,	1205.5)(	.696,	1.169)	1.361
20(	642.5,	792.5)(	2080.5,	1154.5)(	-1.194,	-.271)	1.225
21(	863.5,	765.5)(	2225.5,	1096.5)(	-.428,	-1.085)	1.167
9(	982.5,	313.5)(	2219.5,	639.5)(	1.006,	-.541)	1.143
11(	819.5,	522.5)(	2146.5,	866.5)(	-1.125,	-.089)	1.128
24(	153.5,	690.5)(	1728.5,	1123.5)(	.243,	1.102)	1.128
35(	823.5,	848.5)(	2216.5,	1184.5)(	1.111,	.011)	1.111
3(	346.5,	423.5)(	1805.5,	834.5)(	-1.065,	.059)	1.067
26(	614.5,	433.5)(	1990.5,	808.5)(	.165,	1.005)	1.019
31(	446.5,	996.5)(	1987.5,	1383.5)(	-.632,	.790)	1.012
2(	100.5,	477.5)(	1650.5,	923.5)(	-.670,	.694)	.964
36(	262.5,	1014.5)(	1865.5,	1425.5)(	.721,	-.482)	.867
22(	990.5,	625.5)(	2283.5,	943.5)(	-.583,	.638)	.864
34(	879.5,	943.5)(	2272.5,	1269.5)(	.813,	-.072)	.816
12(	834.5,	623.5)(	2177.5,	963.5)(	-.475,	.457)	.659
7(	588.5,	178.5)(	1923.5,	561.5)(	.654,	.012)	.654

Press: [G]o; e[X]it; <cr> for next page:

18(	989.5,	518.5)(	2262.5,	839.5)(	-.014,	.608)	.608
23(	470.5,	700.5)(	1946.5,	1088.5)(	.260,	.538)	.598
1(	126.5,	270.5)(	1629.5,	717.5)(	.407,	-.350)	.537
30(	420.5,	852.5)(	1942.5,	1243.5)(	.097,	-.512)	.521
28(	123.5,	643.5)(	1698.5,	1080.5)(	-.253,	-.401)	.474
19(	650.5,	645.5)(	2057.5,	1009.5)(	-.011,	-.244)	.244
5(	382.5,	252.5)(	1797.5,	662.5)(	.117,	-.023)	.119

Press: [G]o; e[X]it; <cr> for next page:

Residual plot (Set 1 Units):RMS=(1.341 .798) Distance= 1.561

Residual plot (Set 1 Units/RMS (... distance

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:          15   31  26          37 27   :
:                12 23                  :
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:          3320    30 1369 17           :
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:32              21 :                   :
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APPENDIX 2

Introduction to Remote Sensing

1. Remote Sensing Model

Remote sensing is a technique for obtaining data about objects or phenomena without being in physical contact with them. The distance between the object(s) and sensor(s) could vary from several metres to thousands of kilometers. Electromagnetic energy (e.g. sunlight) transmitted from a radiation source interacts with objects on the earth's surface and is re-transmitted through the atmosphere as shown in Figure 1. Remotely deployed sensors such as photographic cameras and electronic detectors sense and record the returned energy. This energy is converted to data products such as photographic products or computer tapes and then analyzed.

The choice of analysis technique depends on the data type and information required. Remotely sensed data is generally analyzed in conjunction with reference map and field observations. The extracted information is then suitably packaged or integrated for the intended users. Commonly used formats are hardcopy maps, or computer files as input to a GIS (Aronoff, 1989).

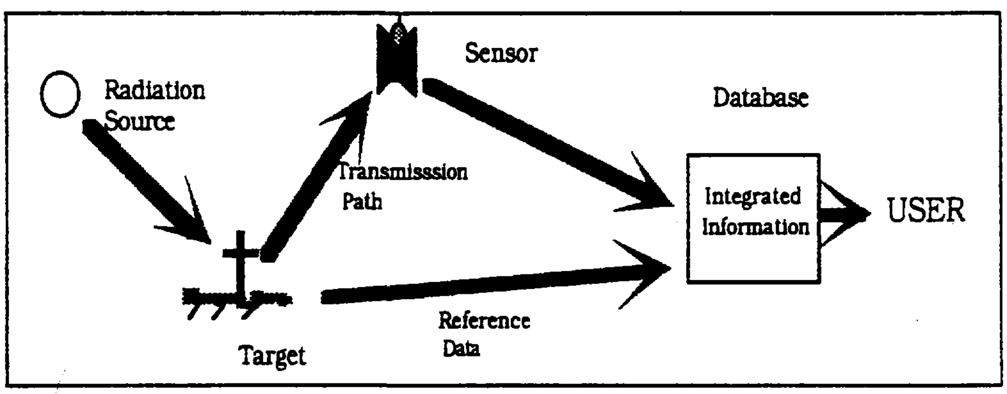

FIGURE 1

Remote Sensing Model

2. The Electromagnetic Spectrum

The electromagnetic spectrum is separated into eight major divisions from high to very low frequency pulse emissions. For purposes of this study, only satellite sensors operating in the visible and infrared portions of the electromagnetic spectrum will be considered. Figure 2 shows the range of wavelengths detected by LANDSAT, SPOT and Soviet satellite sensors. For example, LANDSAT TM sensors simultaneously scan a broad range of the electromagnetic spectrum (i.e. multispectral sensing) as opposed to aerial photography and its limited range. Multispectral data allows for a greater flexibility in feature discrimination.

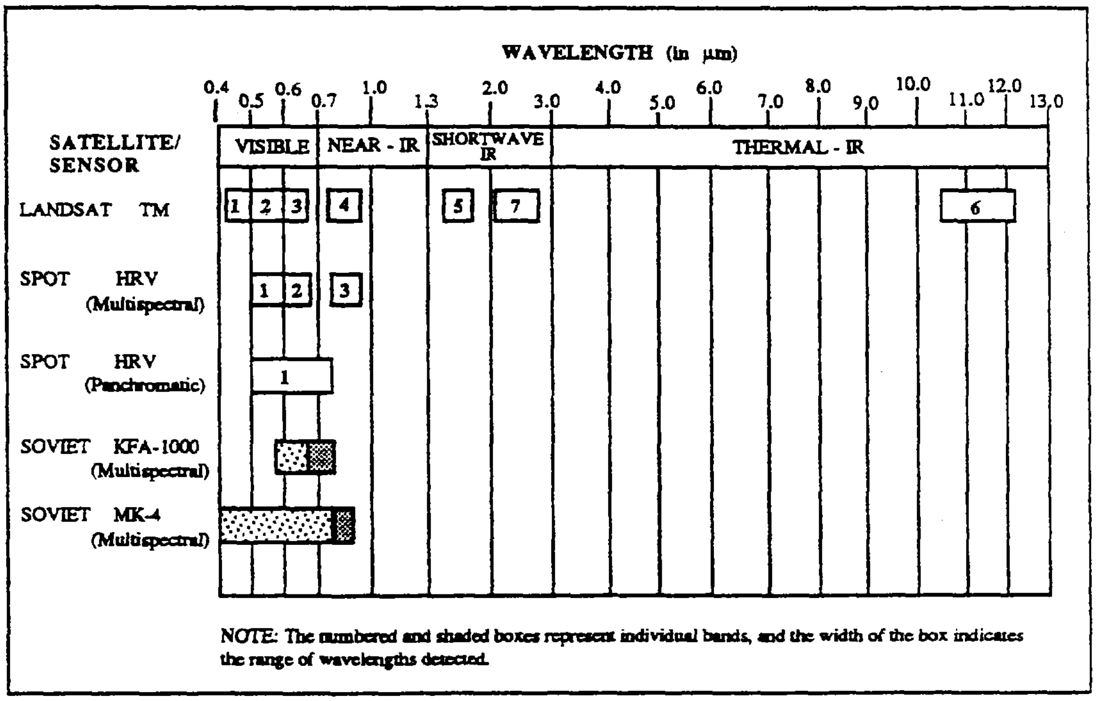

FIGURE 2

Wavelengths Detected by Operational Satellites (after Aronoff, 1989)

Most resource mapping is done using remote sensing. For example, aerial photography has been used to produce virtually all topographic, forestry, geology, land use and soil maps. More recently, airborne radar and multispectral scanner data as well as satellite imageries are increasingly used for these types of mapping applications (Aronoff, 1989). As well, satellite imageries have been used by the Surveys and Mapping Branch, EMR, in collaboration with Gregory Geoscience Ltd. in an operational programme for the revision of 1:250,000 maps and change detection of the 1:50,000 series. Table 1 depicts spectral regions of operational satellite sensors and corresponding applications.

TABLE 1

Spectral Regions and Principal Applications

SPECTRAL REGION	PRINCIPAL APPLICATIONS
Visible	Road network detection Built-up areas definition Coastal water mapping Soil vegetation differentiation Deciduous/coniferous differentiation
Near Infrared	Biomass surveys Species differentiation Water body delineation
Shortwave Infrared	Snow/cloud differentiation Vegetation moisture measurement
Thermal Infrared	Vegetation stress measurement Thermal mapping

3. Benefits and Limitations of Satellite Data

The benefits of satellite data include:

- Synoptic view - each satellite imagery covers an extensive area eg. 3, 600 km^2 to 32, 000 km^2.
- Continuous coverage - some sensors (e.g. SPOT HRV) are pointable devices that allow for coverage of an area even between satellite passes.
- Multi-temporal information - data can be collected at various points in time since one location on the Earth's surface is revisited at regular intervals of satellite passes (eg. 14-26 days).
- Multi-spectral information - satellite sensors can acquire data simultaneously in several spectral regions.
- Digital format - satellite data are available in both hardcopy and digital formats allowing for flexibility in processing
- Availability - readily available on order or from image archives. Users may specify their area of interest i.e., concept of sensing-upon-request.

Limitations of satellite information are:

- Resolution - spatial resolution of satellite data is poorer than that of airborne systems, but the data has broader spectral resolution.

- Cost - satellite data may appear prohibitive in cost because the area of coverage is extensive. However, the cost per square unit may be less.
- Ease of Interpretation - interpretation requires experienced personnel. Computer processing requires a capital investment in equipment.

4. Examples of Satellite Borne Sensors

Table 2 summarizes the specifications of satellite sensors such as the LANDSAT Thematic Mapper, SPOT HRV Multispectral and Panchromatic sensors, and various Soviet space photographic platforms.

LANDSAT THEMATIC MAPPER

The Thematic Mapper sensors of LANDSATs 4 and 5 operate in seven spectral bands (refer Figure 2). These spectral bands are well suited for showing contrasts between specific features, thus facilitating their corresponding detection and identification. The most appropriate band or combination of bands of a LANDSAT image should be selected for each interpretive use. The most commonly used bands are 3, 4 and 5 which are in the visible to shortwave infrared region. This band combination is useful for identifying patterns in drainage networks, roads, railways, power lines, built-up areas, wetland vegetation and soil patterns within fields.

SPOT (MS and PAN)

The two High Resolution Visible sensors of the SPOT-1 spacecraft are designed to operate in either panchromatic or multispectral mode in the visible and infrared portions of the electromagnetic spectrum. The panchromatic mode images the earth at a resolution of 10 m and the multispectral mode at 20 m. Multispectral data provides more spectral information for feature identification while panchromatic data provides better spatial resolution for discerning internal detail.

SOVIET SATELLITE SENSORS

The Soviet Union has recently given the world access to its high resolution space photography; available only in hardcopy format. However, they are the most spatially accurate data available (i.e. spatial resolution of 5 m). The reliability of obtaining the Soviet space photographs have yet to be tested.

APPENDIX 3

Evaluation of potential merits of multi-source spatial data analysis in mineral exploration

1. INTRODUCTION

1.1 The Geological Map

Geological information contained in such maps is constrained by the existence of rock outcrops. Randomly distributed point data (outcrops) is interpreted on the basis of field experience, topography, and occasionally instinct.

The geological map, therefore, cannot compare with the accuracy of topographic, geophysical, and other types of maps. GEODAT has developed a new method of representing geological information, which incorporates various types of geology related data. A digital database containing various data types enables their analysis and the creation of a new type of more accurate geological map.

2. DATA SPECIFICATIONS

2.1 Data Types

Readily available spatial information used by GEODAT in successful and cost effective evaluation of various mineral exploration sites is described below.

Coverage over most of Canada is available for each of; airborne total field magnetics, NTS topographic maps, LANDSAT-TM, and -MSS. In addition reduced coverage by vertical gradiometer magnetics and radiometrics is also accessible.

Geological maps at various scales, projections, and detail have been compiled within the past century by government and the private sector. The geologic features portrayed on these maps represent an interpretation of the actual lithologic and structural information as inferred from randomly distributed points.

Spectral (satellite imagery), magnetic (airborne surveys), and morphologic (topography) characteristics of rock outcrops can be identified and searched for using computer systems. The spatial extent of any given area to be searched are limited only by the resolution of the analysed data.

The analysis techniques and contributions of all data types to the geological knowledge base is summarized in Table 1.

2.2 Data Formats

Spatial information can be represented in one of the following ways:

(a) Points . . . . outcrops, geochem sample sites, drill holes;
(b) Lines . . . . litho-contacts, faults, structural trends;
(c) Polygons . . . bedrock geology, soil geochemistry;
(d) Contours . . . aeromagnetics, topographic elevation;
(e) Raster . . . . satellite imagery, interpolated contours.

3. DATA ANALYSIS

3.1 Introduction

Spatially registered data can be analysed individually and collectively. Results of single type data analysis can serve as input into overlays and statistical analysis.

3.2 Satellite and airborne imagery

In Canada, extensive vegetation, snow, and ice cover hinder the determination of relations between the surface and subsurface phenomena. However, other sources of readily available information exist which can be used in the interpretation of the lithology and rock structure.

TABLE 1.

THE GEOLOGICAL KNOWLEDGE BASE

DATA TYPE	INFORMATION CONTENT	ANALYSIS TECHNIQUE	PRODUCT
Satellite Imagery	Multispectral (visible, infra-red, & thermal).	- lineament extraction - tonal enhancements (definition of geobotanical anomalies). - multi-temporal analyses	- maps - statistical information
N.T.S. Topo Base	- geographic reference - elevation - cultural features	- slope factor calculation - sun illumination simulation	- maps
Airborne Total Field Mag.	- rock magnetic properties	- first and second order vertical derivatives - residual calculation - upward and downward continuation - depth, shape, and orientation modelling - data filtering	- maps - plotted profiles - depth calculations
Geological Maps	- outcrop locations - lithologic classification - structure	- outcrop characteristic correlation with other data types - lineament correlation	- lithologic probability contour map - lineament maps - statistics for either
Other Common Geophysical And Geochemical Data	- VLF - gravity - seismic - radiometrics - stream samples - soil & till sampling	- varied depending on data type	- contour maps - statistics

The increased spectral and spatial resolution of recently available imagery provides information in the infrared, thermal, and microwave spectral regions. Subtle changes in vegetation physiology (chlorophyll content, cellular structure) resulting from the local accumulations of mineral substances (heavy metals) can be detected in the long wavelength (> 2µm) portion of the EM spectrum. A recent gold discovery using infrared and thermal sensors contained in an airborne Thematic Mapper documents the potential of this technique.

Skillings Mining Review
July 23, 1988, p.18

Oregon Gold Discovery Made by Airborne Thematic Mapper

An Earth Search Sciences Joint Venture

Earth Search Sciences Inc., Salt Lake City, announced significant gold mineralization recently discovered in eastern Oregon. Surface assays received to date range from .02 oz. per ton to .29 oz. per ton from mineralized shale and diorite within a two mile radius. A result is a 25-ft. channel sample grading .24 oz. per ton from oxidized and brecciated shale near its contact with a diorite pluton. A series of plutons contained within shales and minor limestones occur throughout a five-mile strike zone. Anomalous zones identified on the Airborne Thematic Mapper (ATM) imagery lie within this zone and are similar to those ATM anomalies known to be due to iron oxide enrichment in soils around the discovery itself. A major soil geochemical survey will be undertaken immediately to delineate trenching and drilling targets.

The joint venture has now leased about 6500 acres in a contiguous block covering the discovery and the exploration play along strike. The area supported considerable placer mining around the turn of the century but is virtually unexplored for deposits amenable to modern mining methods.

Under the terms of the joint venture, ownership of the property is 50% by Earth Search Sciences Inc. and 50% by Beaver Resources Inc. of Vancouver B.C. and Goldsearch Resources (U.S.) Inc.

It is believed that this discovery is the most significant ever reported in the western U.S. directly attributable to remote sensing techniques. The joint venture has a number of other prospects staked and under active field investigation in both Oregon and Nevada, which were found using the project's unique 5.5 million acre ATM data base.

Digital image analysis of LANDSAT Thematic Mapper data is commonly used by GEODAT in mineral exploration projects. Digital processing enhances the subtle changes in vegetation, "geobotanical anomalies", which may not be apparent by simple inspection.

Image discontinuities (lineaments) can be extracted using a variety of procedures. Lineaments can represent faults, fractures, shear zones, or other geologic trends which may determine the spatial distribution of epigenetic mineral deposits.

The significance of digital image processing becomes apparent given, that the human eye can distinguish approximately 12 grey tones as opposed to 256 used by the computer. Displaying images as colour composites further increases the tonal range to approximately 1.5 million possible colour-tone combinations. Hence, the computer is capable of detecting subtle tonal gradients and patterns in the imagery which would go undetected by the human eye.

Base maps plotted from remotely acquired imagery depict recent land use / land cover conditions and aid the geologist in locating new access roads and clearcut areas.

3.3 Geophysical data

Digital aeromagnetic total field and vertical gradient data are becoming increasingly common. The Geological Survey of Canada supplies magnetic data in raster format easily integrated with satellite/airborne imagery. Simple digital overlay of enhanced imagery and geophysical data enables rapid visual correlation. Various processing techniques aimed at delineating anomalies, depth estimates and thresholding, can be used.

3.4 Geochemical data

An example of the incorporation of reconnaissance geochemical stream sediment data represented in image form is given in Appendix IV. Promising exploration targets were defined using this data in conjunction with topographic, geological, and mineral occurrence maps on the basis of the correlation of positive indicators. The technique is in effect self calibrating using known mineral occurrences to define those factors most diagnostic of a specific mineral showing in the geologic environment under study.

3.5 Radiometric data

Digital image processing of airborne τ-ray spectrometric data has been successfully used to discriminate areas underlain by either granitic or metasedimentary rock units (Appendix I). Both lithological units were covered by glacial till. Distinction of two types of granitic rock and partition of granitoids into "phases" was also accomplished.

3.6 Topographic data

Digital elevation data can now be obtained from L.R.I.S. for the Maritimes at a nominal cost. The inclusion of topography facilitates correlation of surface morphology (i.e. slope factor) and bedrock geology. In areas of Canada where a digital topographic base is not available, existing N.T.S. sheets can be digitized.

3.7 Data Integration

A computer search technique, developed by GEODAT, has been used to define new exploration targets in the Heath Steele Mine area of New Brunswick (N.B. D.N.R.E. Open File Report, In press). The two methods of analysing the spectral and geophysical signatures of known gossan occurrences were applied with great success. These methods are referred to as "search by discrete pixel" and "search by area". Both techniques use test areas defined over a known rock outcrop in a naturally vegetated environment (clearcuts, forest burns, and otherwise disturbed regions were excluded from the search).

Statistically unique target areas of spectral and geophysical properties similar to those of the known gossans were defined. A number of these targets have been verified in the field as zones of sulphide accumulation.

A similar study incorporating geophysical data, satellite imagery, and statistical correlations (optimal deposit distance to lineaments), was completed by GEODAT in the Meguma terrain of Nova Scotia. Previously unmapped slate zones containing elevated gold assay values were found (N.S. Dept. of Mines, Assessment Report File).

4. SUMMARY

Collection, storage, analysis and display of spatial data are common tasks for workers in a wide range of disciplines. The tasks involved are often complex and the past process of "map - human interpreter analysis" becomes insufficient for projects involving decision making conclusions.

This is particularly evident in geological investigations where costly operations (i.e. drilling, geochemical, and geophysical surveys) are designed on the basis of a relatively thin database of information - the geological map.

Efficient and cost effective analysis of multi-source spatial data by the latest in computer technology represents a powerful tool which can dramatically improve the success rate in mineral exploration ventures.

APPENDIX 4

Designed Extraction Procedures

The following procedure was designed to be performed on LANDSAT MSS band 7 (near infrared) or LANDSAT TM band 5 (mid infrared). It is a multi-step procedure which modifies the technique described by Moore and Waltz (1984). Directional filtering, generalization (smoothing) and thresholding filtered images to separate lineaments as series of enhanced light/ dark segments are the major steps. Compensation for system look-bias, multiple thresholding and conversion of dark segments into a binary (theme) image are subsequent steps designed by the author.

Low sun elevation images (35 to 45° for slightly rolling terrain) provided best shadowing enhancement of topographic depressions. Ideally, sun illumination maps can be produced to show the effect of topography on appearance. A GIS system with a suitable Digital Terrain Model (DTM) can be used to produce shaded sun illumination maps (Lodin, 1984).

The following steps summarize the extraction procedure (full description in Appendix B):

1) *Low-pass Filtering -*

   Removal of the higher spatial frequency components by replacing each pixel value by an average of a 3x3 window.

2) *System Bias Compensation -*

   LANDSAT bias of preferentially highlighting lineaments perpendicular to the sun illumination is compensated by assigning a different weight to the biased direction (0.7 weight for "main bias" - 1.0 for 2 adjacent directions and 1.2 weight for all others).

Example of a LANDSAT MSS October image of the Heath Steele area (latitude 47°10' - 47°25' North):

Main bias 158 or 338°, therefore:

NW filter weight = 0.7

NNW/WNW filter weight = 1.0 and

remaining filter weights = 1.2

Weight values are derived from radiance differences over topographic gradients in the various directions.

3) <u>*Directional Filtering -*</u>

Filter values are selected from the frequency histogram of the data acquired in 1). Histogram maxima and minima should not exceed 255 and 0 in the output image. Filter sizes 3x3, 5x5, 7x7 and 9x9 were tested for eight directions (Appendix B).

4) <u>*Low-pass Filtering -*</u>

Reduction of noise in images filtered in 2) by a 3x3 low-pass filter.

5) <u>*Thresholding -*</u>

Threshold limits are determined from cumulative histograms, results of 2), (Fig.8). Multiple thresholds (10/90%, 20/80%) are applied to output of 3), such that:

Original value	*New value*
0 to X	*0 to 127*
(X+1)_ to (Y-1)	*128*
Y to 255	*129 to 255*

The values of X (10/20%) and Y (90/80%) are determined from the cumulative histogram (Fig.8).

6) *Segment Selection -*

Display of light/dark segments on grey (128) background shows the noise level. Dark edges indicate shadows or moisture (water absorbs IR energy), often leaking through faults or shear zones. Light segments represent contrasting highlights. One segment type is selected.

7) *Lineament Representation -*

Selected segments Are subsequently assigned a unique integer value corresponding to a color and converted into a theme image.

APPENDIX 5

Statistical Parameters of the Upper Canada Mine Ore Body and Anoki Mine

1;1HJO;1;7mCSR   Om7mClassifier Signature Report   1m
01;48H EASI/PACE V4.3 Om7m14:44 12-FEB-910m

D:\CAS MAPF.PIX   [S 45PIC 1112P 1332L] 08-FEB-91

20:upcan_ta Type:121 [Signatures   ] Last Update: 02:16 12-FEB-91
Contents: upper canada training area
Sample size: 16 Encoding: 1 Threshold: 4.50 Bias: 1.00

Channel	Mean	Deviation	Lo-Limit	Up-limit
4	60.937500	14.153040	6.000	6.000
5	57.062500	11.960710	6.000	6.000
6	129.125000	1.408678	6.000	6.000
12	87.625000	15.000000	6.000	6.000
13	135.937500	2.585265	6.000	6.000
14	41.562500	7.000000	6.000	6.000
37	14.937500	.200000	6.000	6.000

Class Correlation Matrix:

	4	5	6	12	13	14
4	1.00000000					
5	.64761720	1.00000000				
6	-.45416320	-.50495110	1.00000100			
12	.83711530	.62980770	-.34092480	1.00000000		
13	.63532380	.15980430	-.06650203	.77033810	.99999970	
14	.81115590	.50747250	-.11394230	.96318860	.83729690	1.00000000
37	.76410930	.29411440	.00842242	.80725230	.76870270	.88353070

	37
4	
5	
6	
12	
13	
14	
37	1.00000000

Class Covariance Matrix:

	4	5	6	12	13	14
4	200.309					
5	109.629	143.059				
6	-9.055	-8.508	1.984			
12	177.716	112.994	-7.204	225.000		
13	23.246	4.941	-.242	29.873	6.684	
14	80.362	42.488	-1.124	101.135	15.152	49.000
37	2.163	.704	.002	2.422	.397	1.237

37

4	
5	
6	
12	
13	
14	
37	.040

Determinant of Covariance Matrix: .38354880E+04

Inverse Covariance Matrix:

	4	5	6	12	13	14
4	.054					
5	-.020	.031				
6	.389	-.080	5.298			
12	.097	-.042	1.437	.494		
13	.022	.078	.770	.184	.917	
14	-.230	.038	-3.457	-1.136	-.787	2.905
37	-1.595	1.123	-7.692	-1.223	1.437	-1.295

	37
4	
5	
6	
12	
13	
14	
37	191.765

Triangular Inv-Covar. Matrix:

	4	5	6	12	13	14
4	.23198380					
5	-.08458780	.15489510				
6	1.67664600	.39871600	1.52576100			
12	.41903750	-.04503374	.49312800	.27122650		
13	.09630254	.55676660	.25351790	.16193100	.71202590	
14	-.98979150	-.29260000	-1.10161300	-.70533250	-.18954730	.30500550
37	-6.87473800	3.49433100	1.60031400	3.78124800	-1.21356700	-9.43193100

	37
4	
5	
6	
12	
13	
14	
37	4.99993800

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1;1HJ0:1;7mCSR   0m7mClassifier Signature Report   1m
01;48H EASI/PACE V4.3 0m7m14:41 12-FEB-910m

D:\CAS_MAPF.PIX   [S 45PIC 1112P 1332L] 08-FEB-91

19:upcan_ta Type:121 [Signatures   ] Last Update: 22:29 11-FEB-91
Contents: upper canada training area
Sample size: 16 Encoding: 1 Threshold: 10.50 Bias: 1.00

Channel	Mean	Deviation	Lo-Limit	Up-limit
4	60.937500	14.153040	5.500	5.500
5	57.062500	11.960710	5.500	5.500
6	129.125000	1.408678	5.500	5.500
12	87.625000	15.000000	5.500	5.500
13	135.937500	2.585265	5.500	5.500
14	41.562500	17.571170	5.500	5.500
31	114.812500	.390312	5.500	5.500
32	120.312500	.768013	5.500	5.500
33	80.187500	.390312	5.500	5.500

Class Correlation Matrix:

	4	5	6	12	13	14
4	1.00000000					
5	.64761720	1.00000000				
6	-.45416320	-.50495110	1.00000100			
12	.83711530	.62980770	-.34092480	1.00000000		
13	.63532380	.15980430	-.06650203	.77033810	.99999970	
14	.81115590	.50747260	-.11394230	.96318870	.83729690	1.00000000
31	-.33022870	.20332790	-.52573590	-.35592520	-.63100140	-.56786110
32	-.33744840	-.00893005	-.55603290	-.52008240	-.68267820	-.70773350
33	.33022870	-.20332790	.52573590	.35592520	.63100140	.56786110

	31	32	33
4			
5			
6			
12			
13			
14			
31	1.00000000		
32	.82095590	1.00000000	
33	-.98000000	-.82095590	1.00000000

Class Covariance Matrix:

	4	5	6	12	13	14

5	109.629	143.059				
6	-9.055	-8.508	1.984			
12	177.716	112.994	-7.204	225.000		
13	23.246	4.941	-.242	29.873	6.684	
14	201.723	106.652	-2.820	253.865	38.035	308.746
31	-1.824	.949	-.289	-2.084	-.637	-3.895
32	-3.668	-.082	-.602	-5.991	-1.355	-9.551
33	1.824	-.949	.289	2.084	.637	3.895

	31	32	33
4			
5			
6			
12			
13			
14			
31	.152		
32	.246	.590	
33	-.149	-.246	.152

Determinant of Covariance Matrix: .20981040E+02

Inverse Covariance Matrix:

	4	5	6	12	13	14
4	.044					
5	-.015	.030				
6	.327	-.056	7.063			
12	.069	-.011	1.071	.619		
13	.035	.065	1.277	.123	1.003	
14	-.079	-.007	-.913	-.611	-.203	.651
31	.213	-.271	1.538	-1.263	.350	1.348
32	-.061	.009	6.977	-.744	1.507	1.323
33	-.213	.271	-1.538	1.263	-.350	-1.348

	31	32	33
4			
5			
6			
12			
13			
14			
31	177.774		
32	1.236	24.721	
33	150.428	-1.236	177.774

Triangular Inv-Covar. Matrix:

	4	5	6	12	13	14
4	.210					
5	-.070	.159				
6	1.555	.328	2.130			
12	.330	.075	.250	.665		
13	.166	.481	.404	-.103	.755	
14	-.375	-.207	-.123	-.663	-.080	.081

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
32	-.290	-.069	3.498	-2.282	-.081	1.368
33	-1.013	1.265	-.177	2.327	-.633	.076

	31	32	33
4			
5			
6			
12			
13			
14			
31	13.011		
32	-.333	2.280	
33	12.213	3.684	2.562

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..\TEMP.PIX [S 15PIC 512P 512L] FEB-91

3:ant_ta Type:121 [Signatures] Last Update: 18:08 FEB-91
Contents:
Sample size: 20 Encoding: 1 Threshold: 4.50 Bias: 1.00

Channel	Mean	Deviation	Lo-Limit	Up-limit
1	60.750000	3.176083	3.500	3.500
2	24.450000	2.132487	3.500	3.500
3	22.300000	4.313931	3.500	3.500
5	128.450000	1.564449	3.500	3.500
6	17.450000	5.705041	3.500	3.500
7	42.650000	19.576200	3.500	3.500
11	46.000000	.001000	3.500	3.500
12	193.000000	.001000	3.500	3.500
13	46.050000	.217945	3.500	3.500

Class Correlation Matrix:

	1	2	3	5	6	7
1	.99999960					
2	.90986860	.99999980				
3	.92508770	.91473340	1.00000000			
5	.51571600	.38891940	.58009240	.99999980		
6	.93613660	.90395920	.94124000	.65516410	1.00000000	
7	-.66082960	-.61904140	-.73706000	-.72463020	-.73012440	.99999970
11	.00000000	.00000000	.00000000	.00000000	.00000000	.00000000
12	.00000000	.00000000	.00000000	.00000000	.00000000	.00000000
13	.16252270	.16675110	.14358660	.37394010	.26339390	-.10137040

	11	12	13
1			
2			
3			
5			
6			
7			
11	.99999990		
12	.00000000	.99999990	
13	.00000000	.00000000	1.00000000

Class Covariance Matrix:

	1	2	3	5	6	7
1	10.087					
2	6.162	4.548				
3	12.675	8.415	18.610			
5	2.563	1.298	3.915	2.447		
6	16.962	10.998	23.165	5.847	32.548	
7	-41.088	-25.843	-62.245	-22.192	-81.543	383.228
11	.000	.000	.000	.000	.000	.000

12	.000	.000	.000	.000	.000	.000
13	.112	.078	.135	.127	.327	-.433

	11	12	13
1			
2			
3			
5			
6			
7			
11	.000		
12	.000	.000	
13	.000	.000	.047

Determinant of Covariance Matrix: .14278740E-09

Inverse Covariance Matrix:

	1	2	3	5	6
1	.1082244E+01				
2	-.2547680E+00	.2703275E+01			
3	-.2017792E+00	-.5580251E+00	.7403929E+00		
5	.1580709E+00	.1344028E+01	-.1914260E+00	.1883245E+01	
6	-.3822879E+00	-.5470526E+00	-.1756847E+00	-.5441833E+00	.6356689E+00
7	-.5446868E-02	.2369418E-01	.1380703E-01	.6668717E-01	-.3408805E-02
11	.0000000E+00	.0000000E+00	.0000000E+00	.0000000E+00	.0000000E+00
12	.0000000E+00	.0000000E+00	.0000000E+00	.0000000E+00	.0000000E+00
3	.5878271E+00	-.1841373E+01	.1134931E+01	-.2719036E+01	-.6558138E+00

	7	11	12	13
1				
2				
3				
5				
6				
7	.8844336E-02			
11	.0000000E+00	.1000000E+07		
12	.0000000E+00	.0000000E+00	.1000000E+07	
13	-.1399691E+00	.0000000E+00	.0000000E+00	.2998483E+02

Triangular Inv-Covar. Matrix:

	1	2	3	5	6	7
1	1.040					
2	-.245	1.626				
3	-.194	-.372	.751			
5	.152	.850	.206	1.047		
6	-.367	-.392	-.523	-.046	.267	
7	-.005	.014	.024	.049	.055	.051
11	.000	.000	.000	.000	.000	.000
12	.000	.000	.000	.000	.000	.000
13	.565	-1.047	1.138	-2.053	-1.338	.468

	11	12	13

```
  1|
  2|
  3|
  5|
  6|
  7|
 11|   1000.000
 12|       .000    1000.000
 13|       .000        .000       4.588

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```

APPENDIX 6

Regional Lineaments -- 1:12,000

NW Lineaments *EW Lineaments*

ENE Lineaments *ESE Lineaments*

NE Lineaments *NS Lineaments*

RADAR Lineaments

APPENDIX 10

Photo Documentation

PHOTO #	***DESCRIPTION***
1	*Area overview, LANDSAT TM, September/1989, bands-1,2,3 (visible). Gauthier Township and claim location defined as red line overlay.*
2	*Detail of 1*
3	*Test area location (Upper Canada mine -- pink, Anoki Mine -- cyan.*
4	*Radar image (C-band), NS, NE lineaments, claim location, base map information.*
5	*Detail of 4*
6	*Defined radar lineaments correlated with mapped faults.*
7	*Detail of 6*
8	*Color enhancement of radar imagery with defined lineaments as line overlay.*
9	*NS, NE lineaments overlayed on the grey-tone background of original LANDSAT band-5.*
10	*NW, NE lineaments overlayed on the grey-tone background of original LANDSAT band-5.*
11	*Detail of 10*
12	*Extracted lineaments (all directions) overlay over multi-date Thermal (band-6) LANDSAT data.*

PHOTO #	***DESCRIPTION***
13	*Radiometric data (total U, Th, K -- as red, green, blue), NE and NW lineaments.*
14	*Ratio of radiometric data, U/K (red), U/Th (green), Th/K (blue) with an overlay of defined lineaments.*
15	*Detail, color-coded aeromagnetic data, extracted lineaments.*
16	*Overview of 15 with a color scale bar.*
17	*Color composite of LANDSAT TM infrared bands-4,5,7 of September/1989. Extracted lineaments overlayed.*
18	*Detail of 17*
19	*Multi-date color overlay of LANDSAT thermal (band-6). Extracted lineaments overlayed as lines.*
20	*Detail of 19*
21	*September/1989 LANDSAT TM thermal band-6 (grey-tone background) overlayed with lineaments extracted from radar imagery.*
22	*Same as 19 -- background color-coded.*
23	*May/1989 LANDSAT TM thermal band-6 (color-coded background) overlayed with lineaments extracted from radar imagery.*

APPENDIX 8

Detailed Claim Area Lineaments with Ground Geophysical Conductors -- 1:2400

APPENDIX 7

Detailed Claim Area Lineaments -- 1:2400

APPENDIX 9

Detailed Claim Area Target Search Results -- 1:2400

Upper Canada Model

Anoki Model

CASAN MINING LIMITED

Gauthier Township Claims
Kirkland Lake Mining Division
Ontario

Exploration Targets, Upper Canada Ore Body

63.6089

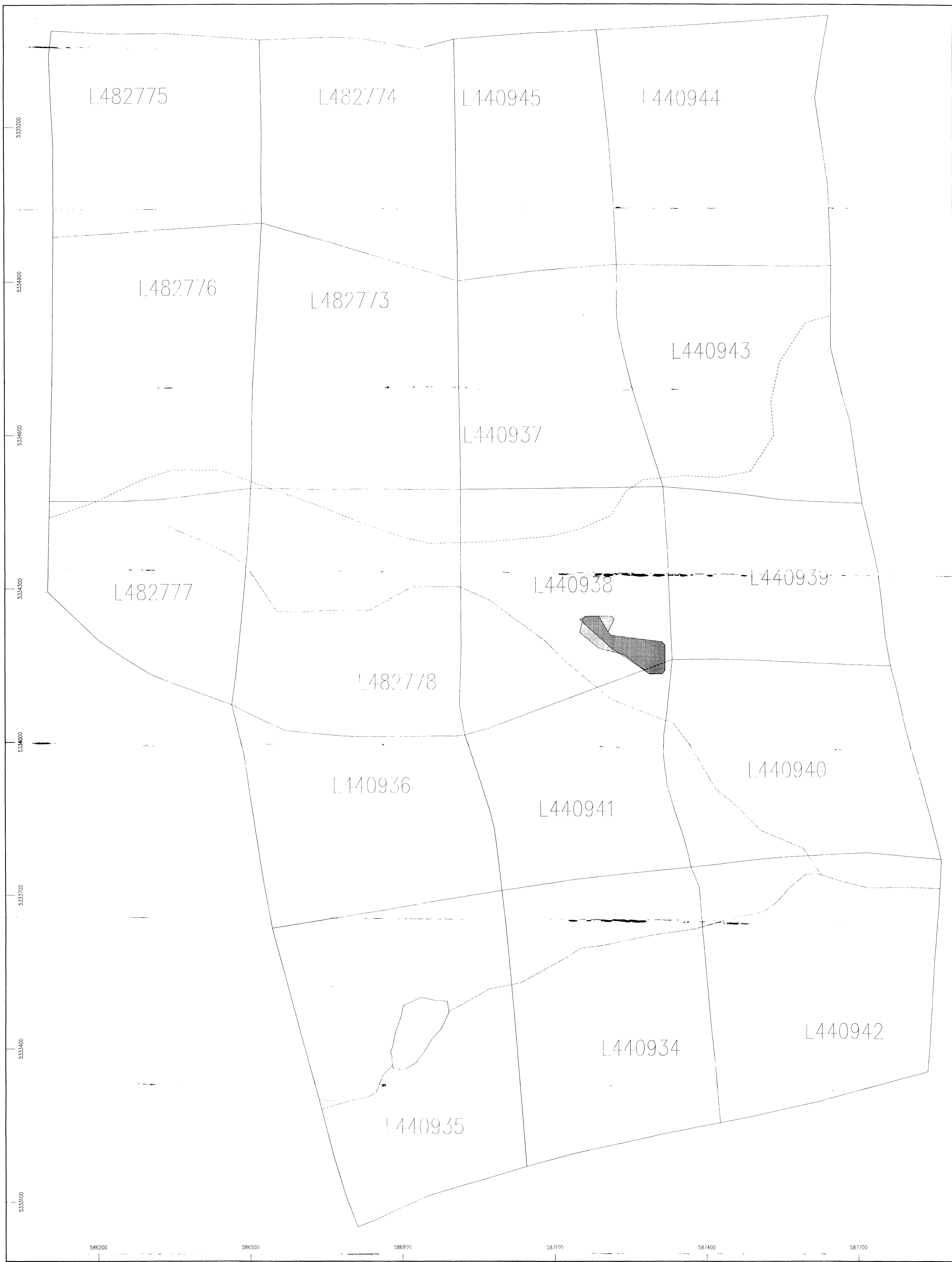
Major Road
Minor Road
Lake
River/Stream

Claim Lines
L482775 Claim Numbers
Exploration Target Tolerance: 6.5 σ
Exploration Target Torerence: 4.5 σ
Input Parameters: LANDSAT Data, Magnetics

Scale 1:2400
Coordinates are in UTM Zone 17.
Map area is part of Gauthier Township.

Drawn By: GEODAT Information Services
301 Woodstock Road
Fredericton, New Brunswick

200



CASAN MINING LIMITED

Gauthier Township Claims
Kirkland Lake Mining Division
Ontario

Exploration Targets, Anoki Ore Body

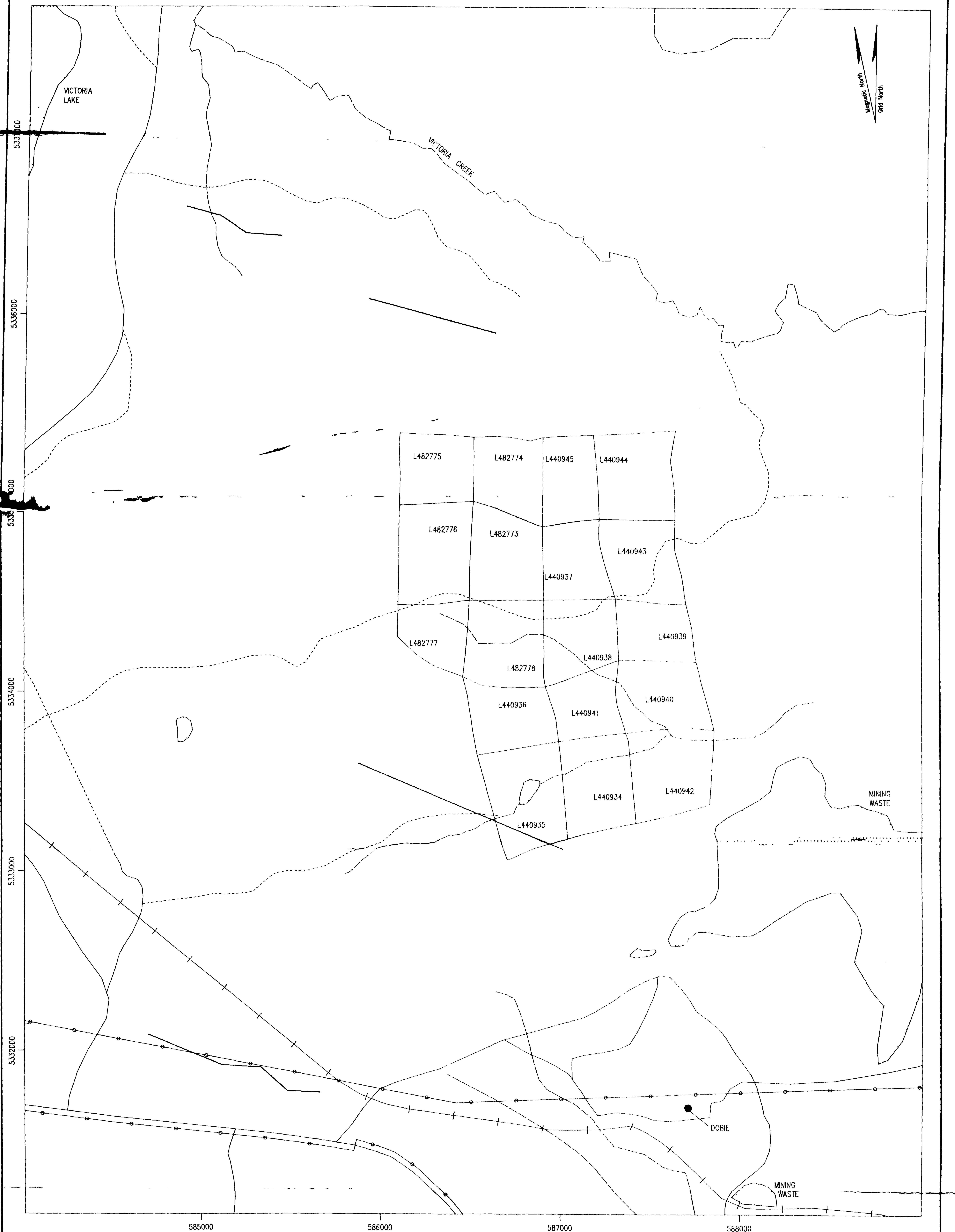
63.6089

Major Road
Minor Road
Lake
River/Stream

Claim Lines
L482775 Claim Numbers
Exploration Target Tolerance: 4.5 σ
Exploration Target Torerence: 3.5 σ
Input Parameters: LANDSAT Data Radiometric Ratios

Scale 1:2400
Coordinates are in UTM Zone 17.
Map area is part of Gauthier Township.

Drawn By: GEODAT Information Services
301 Woodstock Road
Fredericton, New Brunswick



CASAN MINING LIMITED
Gauthier Township Claims
Kirkland Lake Mining Division
Ontario

East-Southeast Lineaments

63.6089

Major Road
Minor Road
Lake
River/Stream
Powerline
Rail Road

Claim Lines
L482775 Claim Numbers
Lineament

Scale 1:12,000
Coordinates are in UTM Zone 17.
Map area is part of Gauthier Township.

Drawn By: GEODAT Information Services
301 Woodstock Road
Fredericton, New Brunswick

32D04NW0054 63.6089 GAUTHIER

220

CASAN MINING LIMITED

Gauthier Township Claims
Kirkland Lake Mining Division
Ontario

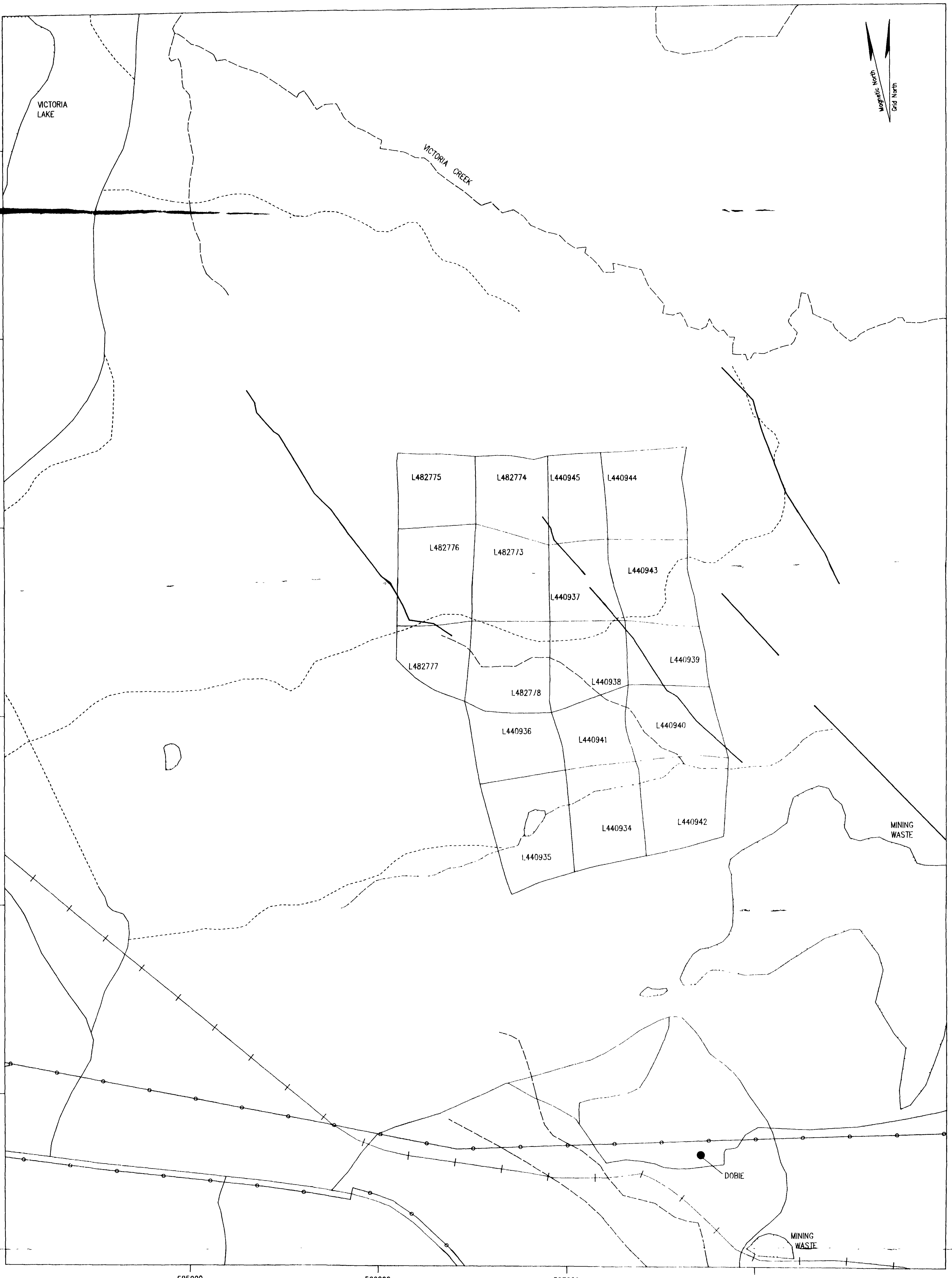
East-West Lineaments

63 6089

Major Road	Claim Lines		Scale 1:12,000
Minor Road			Coordinates are in UTM Zone 17.
Lake	L482775	Claim Numbers	Map area is part of Gauthier Township
River/Stream		Lineament	Drawn By: GEODAT Information Services, 301 Woodstock Road, Fredericton, New Brunswick
Powerline			
Rail Road			

32D04NW0054 63.6089 GAUTHIER

230



CASAN MINING LIMITED
Gauthier Township Claims
Kirkland Lake Mining Division
Ontario

Northwest Lineaments

63.6089

Major Road
Minor Road
Lake
River/Stream
Powerline
Rail Road

Claim Lines
L482775 Claim Numbers
Lineamnet

Scale 1:12,000
Coordinates are in UTM Zone 17
Map area is part of Gauthier Township.

Drawn By: GEODAT Information Services
301 Woodstock Road
Fredericton, New Brunswick

32D04NW0054 63.6089 GAUTHIER

240

CASAN MINING LIMITED

Gauthier Township Claims
Kirkland Lake Mining Division
Ontario

Northeast Lineaments

63.6089

Major Road
Minor Road
Lake
River/Stream
Powerline
Rail Road
Claim Lines
L482775 Claim Numbers
Lineamnet

Scale 1:12,000
Coordinates are in UTM Zone 17
Map area is part of Gauthier Township.

Drawn By: GEODAT Information Services
301 Woodstock Road
Fredericton, New Brunswick

CASAN MINING LIMITED

Gauthier Township Claims
Kirkland Lake Mining Division
Ontario

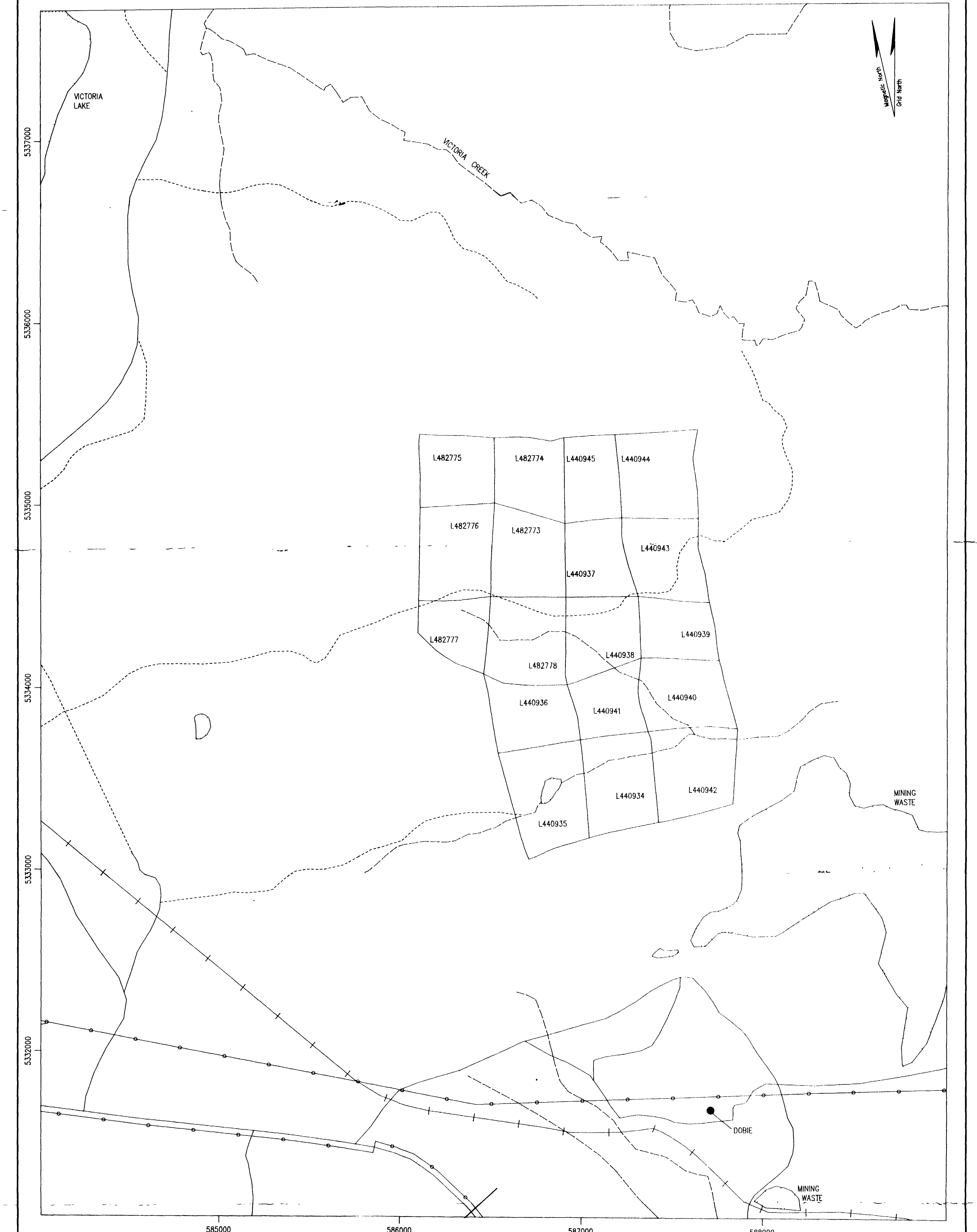
North–South Lineaments

63.6089

Major Road
Minor Road
Lake
River/Stream
Powerline
Rail Road
Claim Lines
L482775 Claim Numbers
Lineament

Scale 1:12,000
Coordinates are in UTM Zone 17.
Map area is part of Gauthier Township.

Drawn By: GEODAT Information Services
301 Woodstock Road
Fredericton, New Brunswick



CASAN MINING LIMITED

Gauthier Township Claims
Kirkland Lake Mining Division
Ontario

East–Northeast Lineaments

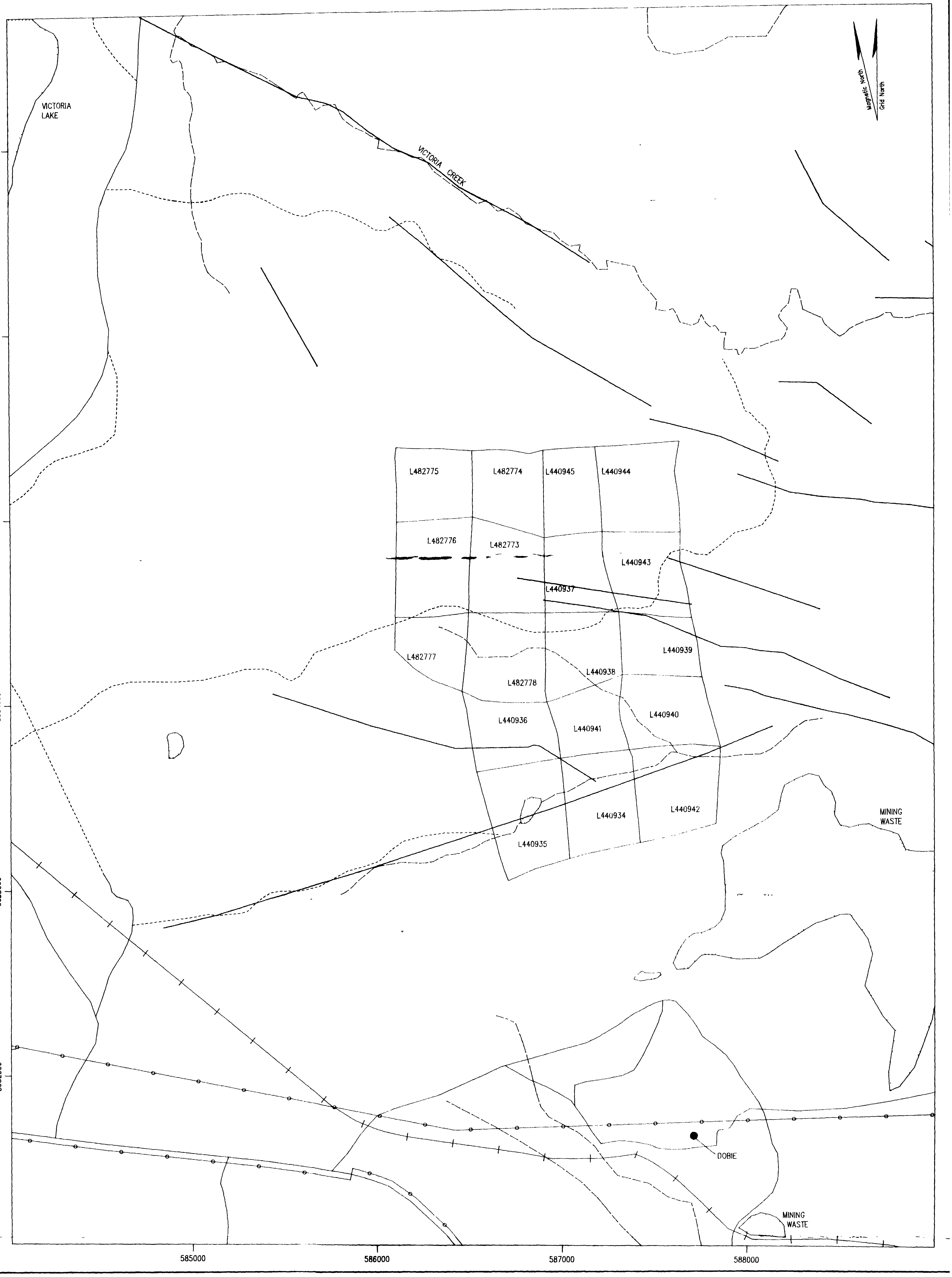
63.6089

Major Road
Minor Road
Lake
River/Stream
Powerline
Rail Road

Claim Lines
L482775 Claim Numbers
Lineament

Scale 1:12,000
Coordinates are in UTM Zone 17.
Map area is part of Gauthier Township.

Drawn By: GEODAT Information Services
301 Woodstock Road
Fredericton, New Brunswick



CASAN MINING LIMITED

Gauthier Township Claims

Kirkland Lake Mining Division

Ontario

Lineaments From Radar

63.6089

Legend	
Major Road	
Minor Road	
Lake	
River/Stream	
Powerline	
Rail Road	
Claim Lines	
L482775	Claim Numbers
Lineament	

Scale 1:12,000
Coordinates are in UTM Zone 17.
Map area is part of Gauthier Township.

Drawn By GEODAT Information Services
301 Woodstock Road
Fredericton, New Brunswick

CASAN MINING LIMITED

Gauthier Township Claims
Kirkland Lake Mining Division
Ontario

Lineaments - All Directions

Major Road
Minor Road
Lake
River/Stream

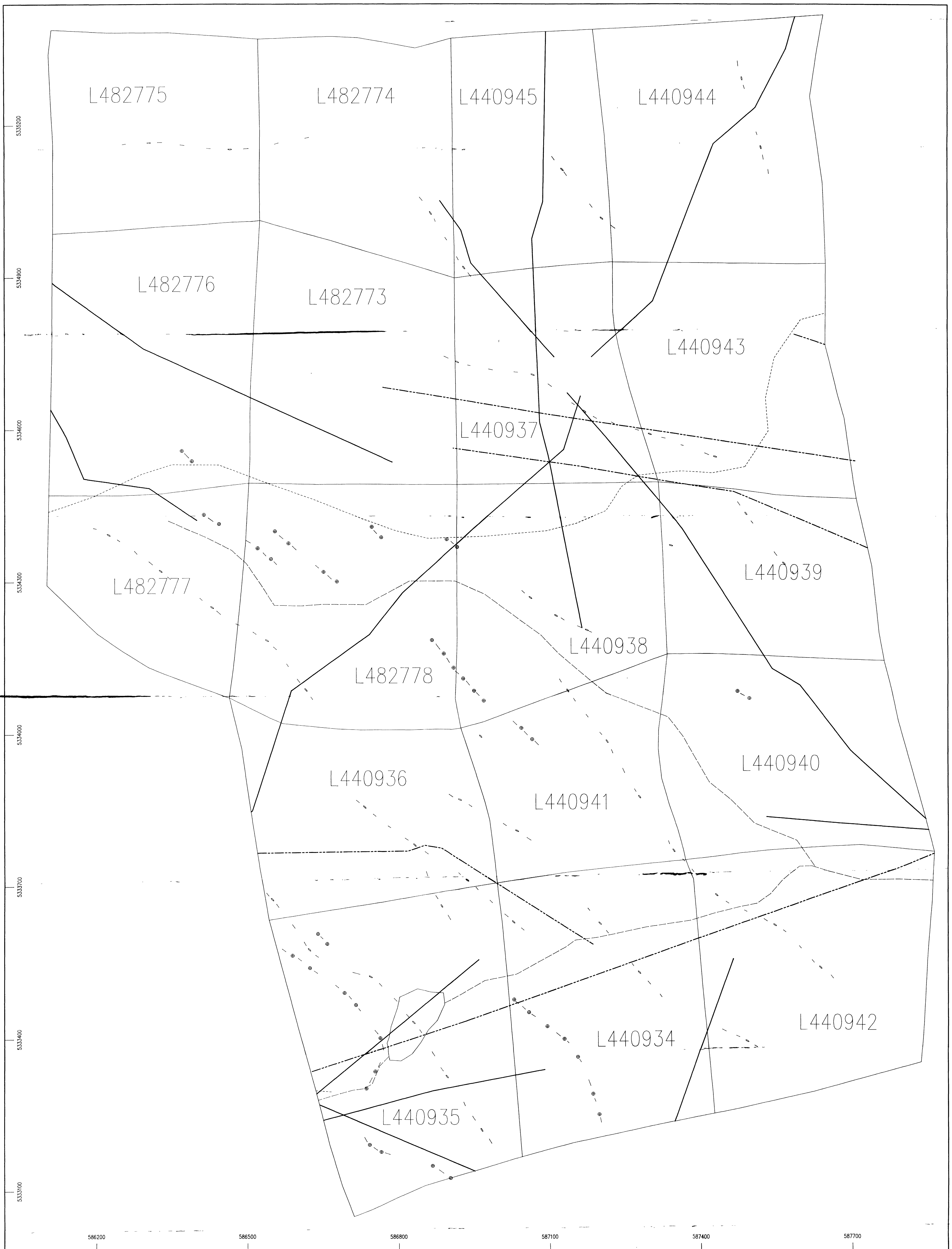
Claim Lines
L482775 Claim Numbers
Lineament From LANDSAT
Lineament From Radar

Scale 1:2400
Coordinates are in UTM Zone 17.
Map area is part of Gauthier Township.

Drawn By: GEODAT Information Services
301 Woodstock Road
Fredericton, New Brunswick

63.6089

290



CASAN MINING LIMITED
Gauthier Township Claims
Kirkland Lake Mining Division
Ontario

Lineaments – Conductors

63.6089

Major Road
Minor Road
Lake
River/Stream
VLF Conductor
Magnetic Conductor
Claim Lines
L482775 Claim Numbers
Lineament From LANDSAT
Lineament From Radar

Scale 1:2400
Coordinates are in UTM Zone 17.
Map area is part of Gauthier Township.

Drawn By: GEODAT Information Services
301 Woodstock Road
Fredericton, New Brunswick

300