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Confidential

Report

By JAPOSAT Satellite Mapping

For **Golden Valley Mines Ltd.**

Remote sensing spectral geobotany litho-structural study, Claw Lake Project, Ontario, Canada, NTS 41P / 11.

January 28th, 2019

By Bronislaw Popiela, P.Geo. M.Sc.

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SUMMARY

The following remote sensing study was undertaken by **Japosat Satellite Mapping** (Japosat hereafter) at the request of and completed for **Golden Valley Mines Ltd.**

The main goal of this mandate is to provide **Golden Valley Mines Ltd** with the satellite value added products regarding their **Claw Lake** property located in Kirkland Lake mining division, about 100 km south of Timmins, Ontario. The study was mainly focused on extracting and mapping the lineaments, computing lineament stress and producing GEOBS geobotany data. Some of the historical geology data provided to Japosat was also compiled with the remote sensing study results and analysed / commented.

The Claw Lake Prospect includes 67 claims and covers an area of about 14.5 sq. km.

To achieve the goal of the study, the following remote sensing data were used: Landsat-8 Thermal InfraRed, SRTM and SPOT 10m data. All acquired data were processed in order to enhance the geologic, geomorphologic, land cover and geobotanical features.

The study was conducted using 3 different approaches: (1) Geobotany, (2) Thermal InfraRed (TIR) radiance, (3) Lineaments extraction/interpretation from remote sensing data including SRTM, SPOT and GEOBS.

Some 846 lineaments with a total length of 262 km and mean orientation of 87 degrees were mapped, while the main linear trend is oriented southwest west - northeast east. These lineaments contribute to several strong stress values and some of them are over the known showings.

The thermal InfraRed radiance data shows mainly small change in value (excluding lake and deforestation radiance). However, the faults previously mapped, as well as other important lineaments, are clearly identifiable on radiance data.

The GEOBS data shows many signature changes. Some of them are marked by a break in signature, which is probably due to faults or lithological contacts.

Bronislaw Popiela, P. Geo., M.Sc, remote sensing expert, was in charge for this mandate. The following report describes the remote sensing work completed in January 2019.

STUDY AREA

The Claw Lake Prospect is located in Kirkland Lake mining division, about 100 km south of Timmins, Ontario. The claims under the remote sensing study cover an area of about 1450 hectares or 14.5 sq. km (**FIG. 1**).

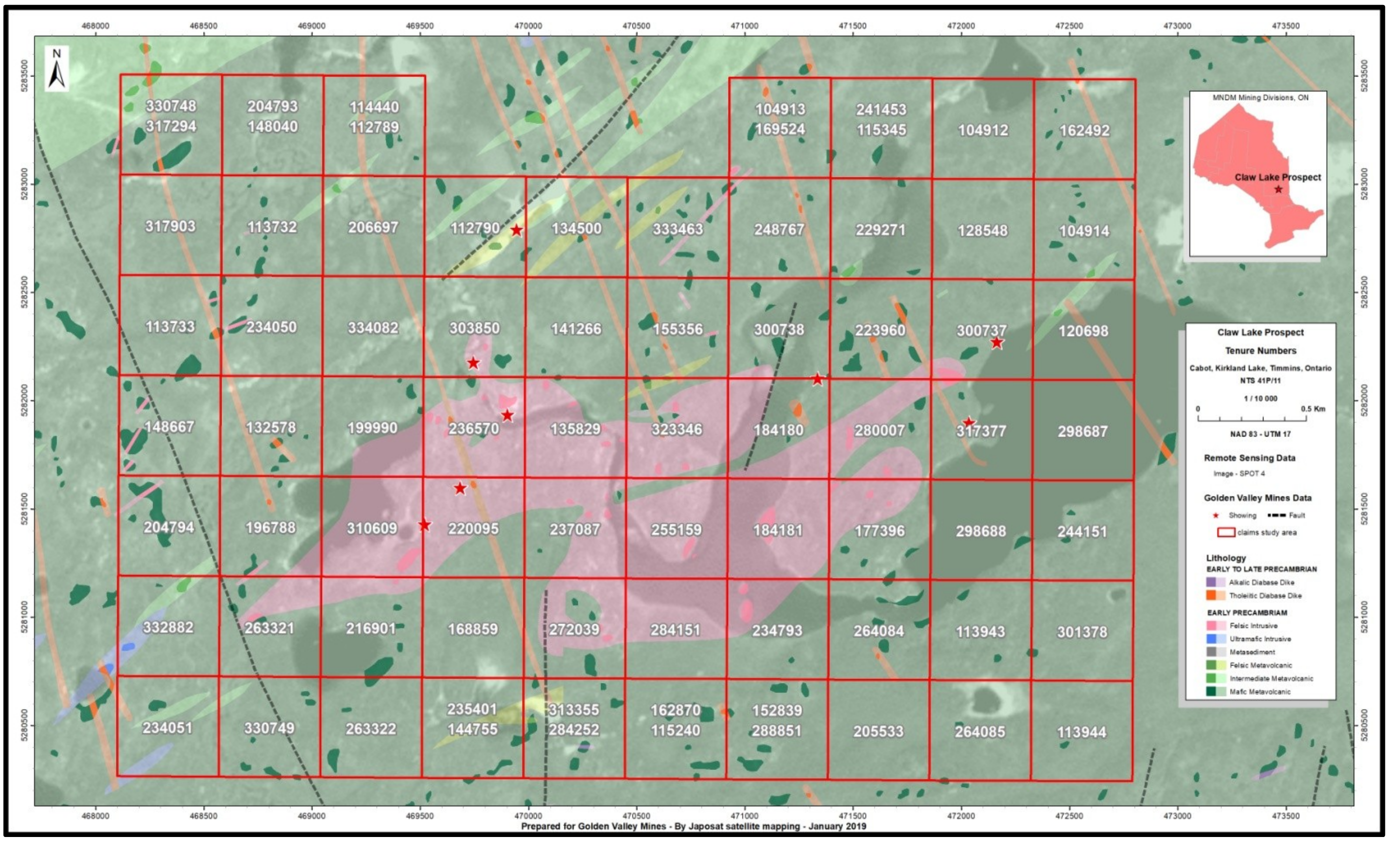

Figure 1. Location, claims of Claw Lake Prospect, SPOT image and geology.

SPECIFICATIONS REMOTE SENSING DATA

The following raw data was acquired and processed for this mandate:

- LANDSAT-8 Thermal InfraRed and Multispectral (pixel 30m)
- SRTM (pixel 30m)
- SPOT panchromatic (pixel 10m)

LANDSAT TIR

The 30m 2-band Thermal InfraRed data acquired by satellite Landsat-8 on September 13th, 2018 was used by Japosat to calculate the thermal infrared radiance over the Claw Lake prospect study area (**Table 1**).

The Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) are the instruments onboard the Landsat 8 satellite, which was launched in February of 2013. The satellite collects images of the Earth with a 16-day repeat cycle, referenced to the Worldwide Reference System-2. The satellite's acquisitions are in an 8-day offset to Landsat 7 (The approximate scene size is 170 km north-south by 183 km east-west (106 mi by 114 mi). The spectral bands of the OLI sensor, while similar to Landsat 7's ETM+ sensor, provide enhancement from prior Landsat instruments, with the addition of two new spectral bands: a deep blue visible channel (band 1) specifically designed for water resources and coastal zone investigation, and a new infrared channel (band 9) for the detection of cirrus clouds. Two thermal bands (TIR) capture data with a minimum of 100 meter resolution, but are registered to and delivered with the 30-meter OLI data product.

Table 1. Landsat TIR data

Data	***Bands***	***Pixel Resolution***	***Capture Resolution***	***Processing level***
Landsat-8	TIR1 TIR2	30 metres	100 metres	RAW

SRTM

The Shuttle Radar Topography Mission (SRTM) is an international research effort that obtained the digital elevation models on a near-global scale from 56° S to 60° N, in order to generate the most complete high-resolution digital topographic database of Earth. SRTM consisted of a specially modified SIR-C/X-SAR radar system that was on board the Space Shuttle Endeavour during the 11-day STS-99 mission in February 2000. To acquire topographic (elevation) data, the SRTM payload was outfitted with two radar antennas. One antenna was located in the Shuttle's payload bay, the other on the end of a 60-metre mast that extended from the payload bay once the Shuttle was in space. The technique employed is known as Interferometric Synthetic Aperture Radar (InSAR). *(Source: NASA-JPL)*

The following SRTM archived data was acquired for the Claw Lake Prospect (**Table 2**).

Table 2. SRTM data

Data	*Bands*	*Pixel Resolution*	*Capture Resolution*	*Processing level*
SRTM	SIR-C/X-SAR	30 metres	1 arc second	Filled finished-A

SPOT 10m

As the delivery of SPOT 1.5m data was delayed, Japosat has used the 10m SPOT imagery instead to deliver the products before the confirmed due date for that project.

SPOT-4 is considered a 2nd generation SPOT-series satellite of CNES, France. The most important advance is the addition of the "Vegetation" instrument, with four spectral bands to allow continuous, worldwide crop monitoring. The data may be used for crop forecasts, environmental studies and other Earth Science applications. The following spectral bands are available with HRVIR instrument:

Table 3. SPOT data

Band name	Spectral range	Spatial resolution
B1	0.50 - 0.59 µm	20 m
B2	0.61 - 0.68 µm	20 m
B3	0.79 - 0.89 µm	20 m
Pan	0.61 - 0.68 µm	10 m
SWIR	1.58 - 1.75 µm	20 m

The SPOT image used in this study was acquired May 27th, 2006. (**FIG. 1 and 2, Table 3**)

APPROACH AND METHODOLOGY

Technology and Method

The following sections present an overview of the methodology that was applied by Japosat in accordance with the project goals to generate the satellite value added remote sensing geology products. Not all details of the procedures are described as they are the intellectual property of Japosat.

Image Processing

All remote sensing data was first pre-processed and processed using Geomatica 2016 (PCI Geomatics) image processing software and then, imported into ArcGIS data base project for further analysis. The UTM 17 North projection (UTM 17 N) and NAD 83 datum were used to register the geospatial layers for analysis and display purposes.

GeoBS LS MAT

The GEOBS LS MAT technology (Geobotany Spectral Litho-Structural Mineral Alteration Targeting) is based on the multispectral geobotanical approach that can be adapted to project goals and the sector of interest. The method is built around the calculation of different vegetation indices, including those that target and/or enhance the vegetation chlorophyll content, anthocyanin, chlorophyll Red Edge, plant pigments, water content, and many other plant features. The output vegetation indices are then used to produce the geobotany GEOBS image that is a representation of the geochemistry change within the remotely sensed vegetation / soil / rock.

The purpose of the method is the following:

1. To map the spectral variations/anomalies present in the geochemistry of the vegetative cover;
2. To map the litho-structural features/changes in the rock type/cover type;
3. To combine the geobotanical/soil results with the litho-structural interpretation and;
4. To extract/identify the mineral exploration targets.

Landsat Thermal Radiance

The thermal infrared (TIR) bands are commonly used to calculate the temperature of Earth's surface. In our case, we used these bands to calculate the thermal infrared radiance of the study areas. In our view, a change in radiance may indicate a lithological / mineralogical change or a presence of faults or fracture systems.

The targeted features must be important in size or in TIR signature as the Landsat TIR data is a regional scale data commonly used to produce the maps at 50K - 250K scale.

Lineaments Detection

To avoid a confusion regarding the meaning of the term lineament, the following definition is used to explain the linear features on remote sensing data in geological studies. A lineament is a linear distinctive feature, whose parts show a rectilinear and/or curvilinear correlation in two dimensional space. Most likely, it is a surficial and/or subsurficial expression of geological features. Thus, the detection of lineaments has an important significance in geology. Such features can represent contacts, faults, folds or fracture zones and can signify a favourable environment for ore deposits. The interpreters typically encounter the exposed or hidden lineaments. The exposed lineaments are readily identifiable by their geomorphologic expressions. The hidden lineaments are indirectly recognizable by their subtle influence/control of certain physiographic features.

Numerous extraction techniques have been developed in the past in order to improve the structural geology interpretation. In this study, the high frequency wave filtering technique, as well as band ratioing, principal component calculation and band composites will be applied to the satellite bands in order to enhance, interpret and map the lineaments. In addition, every selected satellite band and DEM data will be separately stretched or filtered to gain the best contrast and color balance for visual interpretation. Also, all extracted lineaments will be validated by using a top-down interpretation technique. With the capability of seeing terrain from different azimuths and elevation angles, this technique helps to detect / confirm and correctly draw the observed lineaments. Hence, the resulting interpreted lineaments represent what is presumed to correspond to the geo-structural or lithological features.

Spatial Density / Stress of Lineaments

Definition: the spatial density analysis captures the identified quantities of some phenomenon and spreads them across the surrounding surfaces based on the quantity that is measured at each location and the spatial relationship of the locations of the measured quantities. Therefore, the density surfaces show where the point and / or line features are concentrated /stressed. In our case, the input lines features are the lineaments extracted and interpreted from satellite data, while the input point features are representing the intersections of the interpreted lineaments. Since both the points and lineaments do not have any assigned numeric value, by calculating density, the created surfaces show the predicted distribution of the lineaments density / stress throughout the study area. The output 2D surface data has the values assigned in accordance with the intensity that is measured at each point / line location and the spatial relationship of the locations of the measured intensities. The resulting high value of density / stress means an intense structural (tectonic) fabric in the immediate area, while low value signifies modest structural (tectonic) fabric in the close neighborhood. The resulting spatial density / stress image is represented by a colour scale from blue to red, where blue means weak structural density / stress and red means strong structural density / stress.

RESULTS

Lineaments

A total of 846 lineaments with a total length of approximately 262 km and a mean orientation of 87 degrees were mapped. The main linear trend over the study area is oriented southwest west - northeast east. Most of them are probably indicating the regional rock foliation and some minor fault or fracture systems. These lineaments contribute to several strong stress values across the studied claims (**FIG. 2**).

By processing SRTM data and calculating the spatial density of lineament stress, we have identified several areas with strong values of stress and being located at the intersections of many lineaments. We recommend investigating these at first (**FIG. 2a**). Also, we recommend compiling the stress data with the geophysics, if available, to see if these strong values correlate with magnetic anomalies.

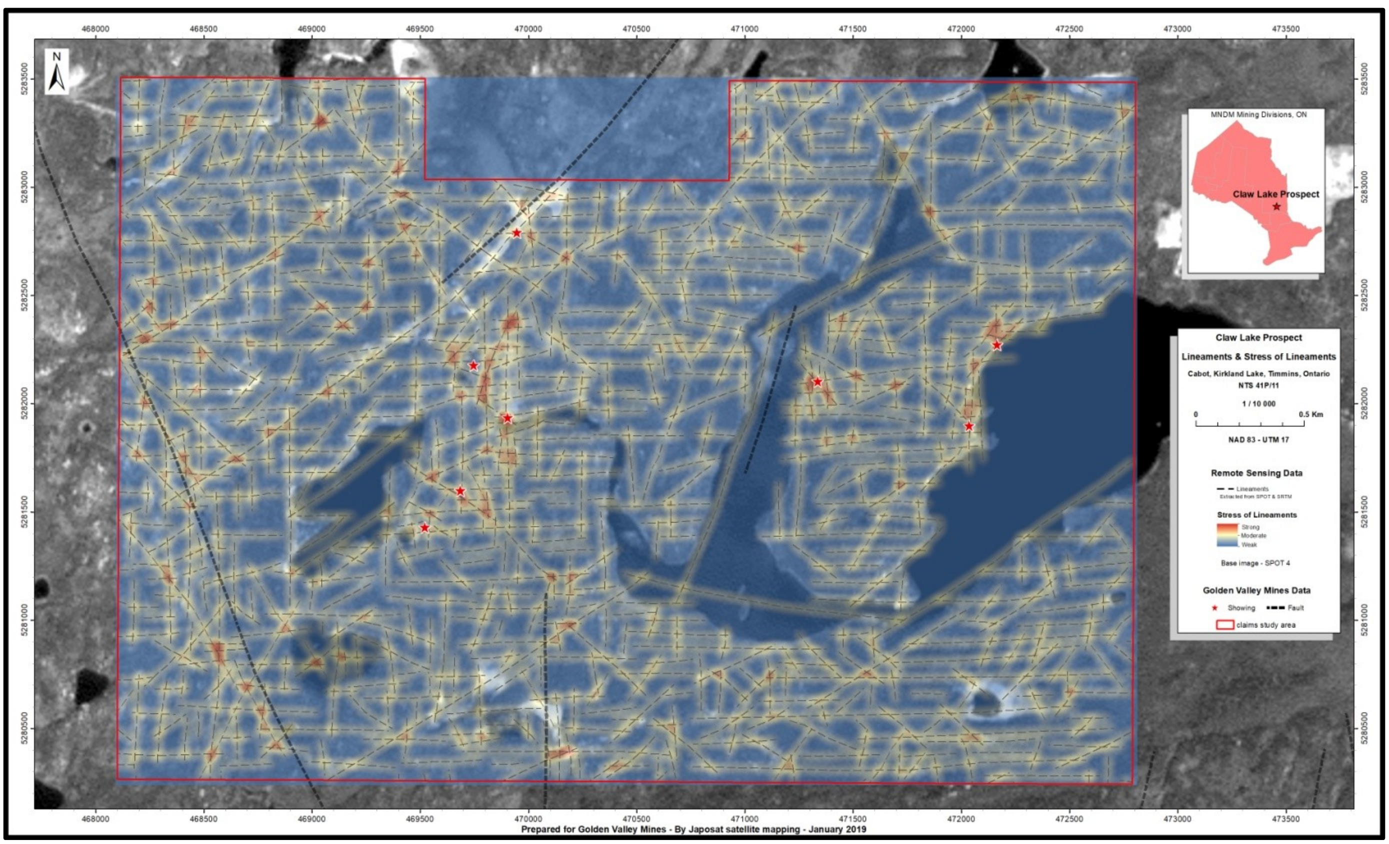

Figure 2. Lineaments and stress of lineaments data.

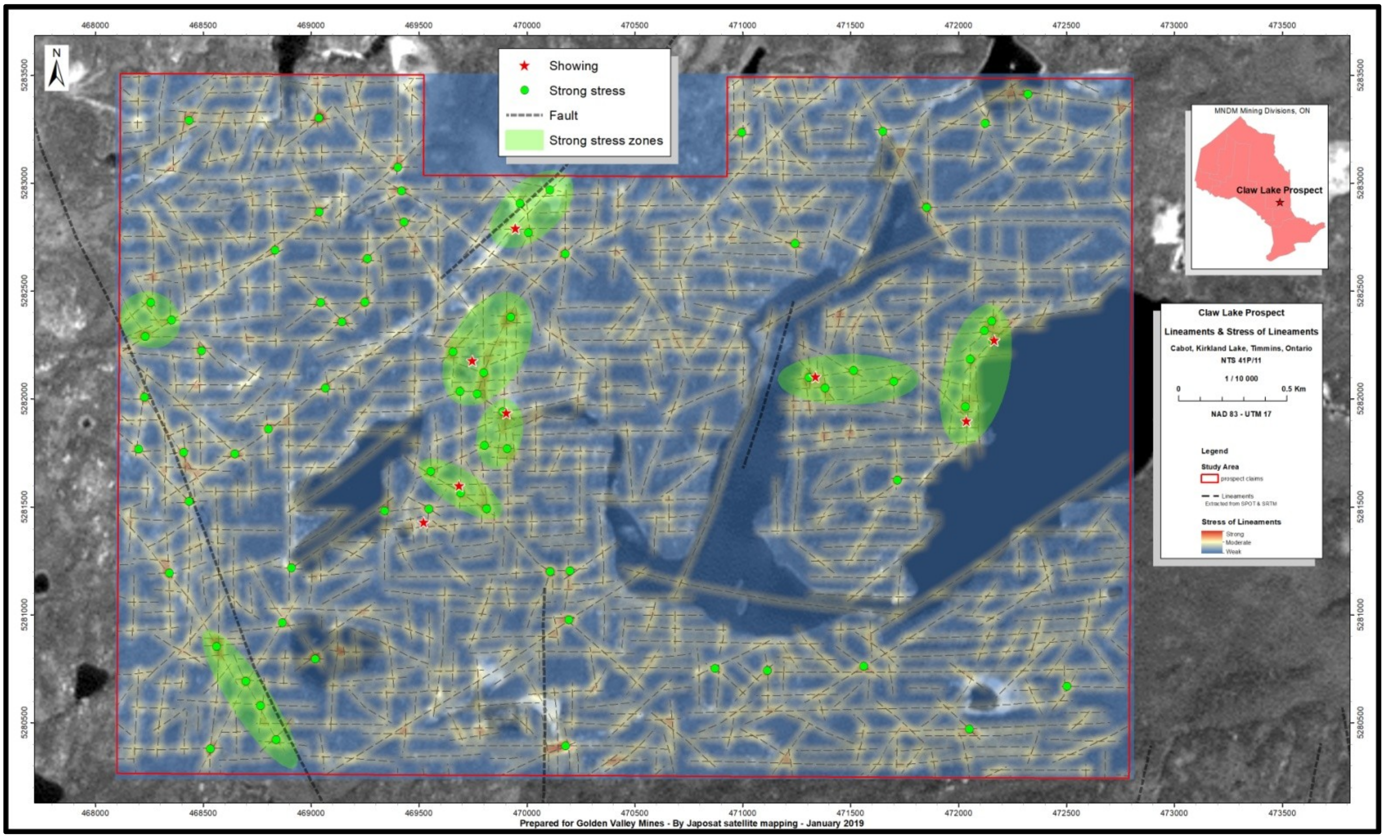

Figure 2a. Strong stress locations.

Thermal InfraRed Radiance

The Landsat Thermal InfraRed (TIR) data was first processed to calculate the radiance values then enhanced to depict the radiance change over the study area only.

The thermal InfraRed radiance data mostly shows a small change in value (excluding lake and deforestation radiance). However, the faults previously mapped, as well as other important lineaments, are clearly identifiable and marked by a net break from strong to moderate or weak radiance values (**FIG. 3**).

Japosat recommends starting the investigation within these weak and strong radiance locations to understand the cause of these anomalous breaks (**FIG. 3a**).

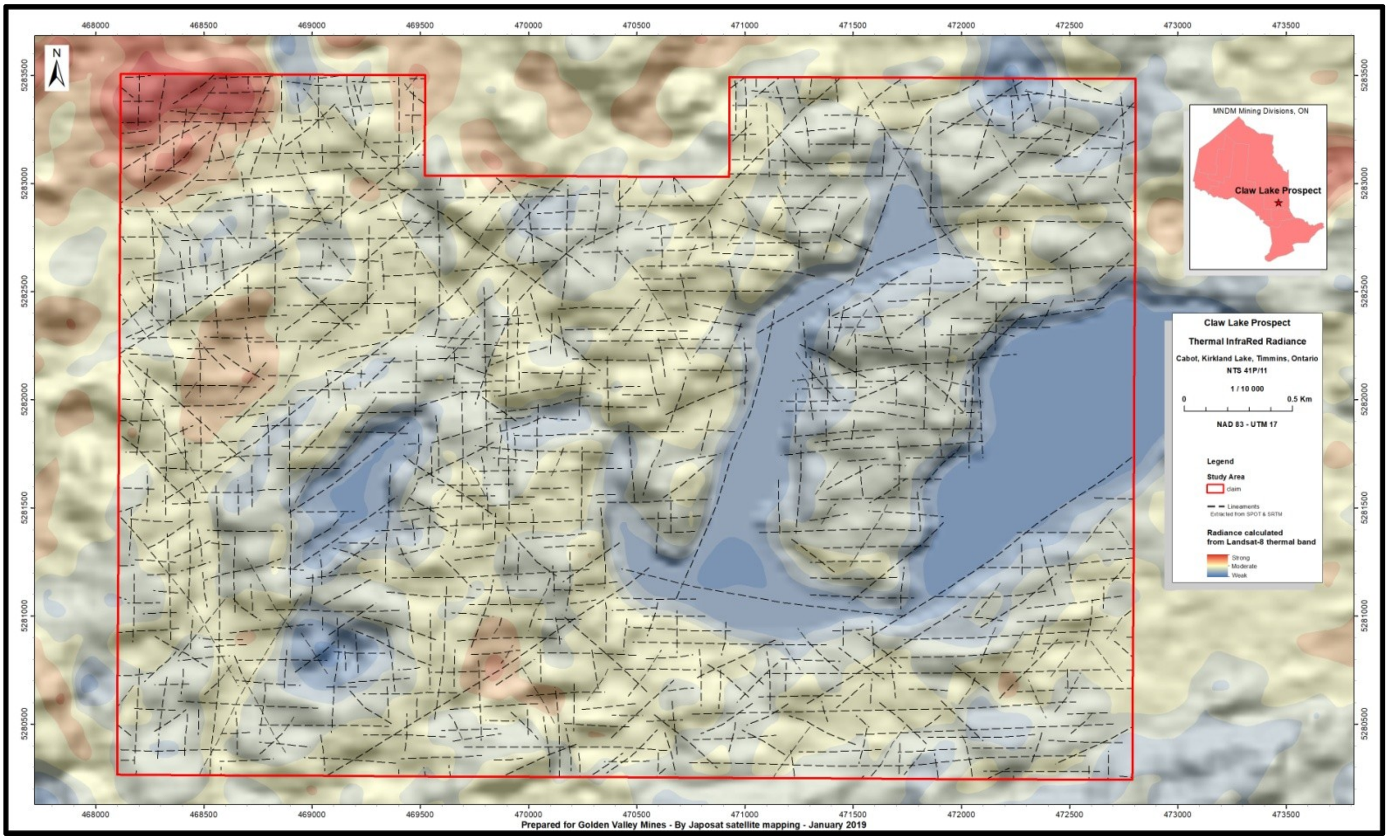

Figure 3. Thermal InfraRed radiance data.

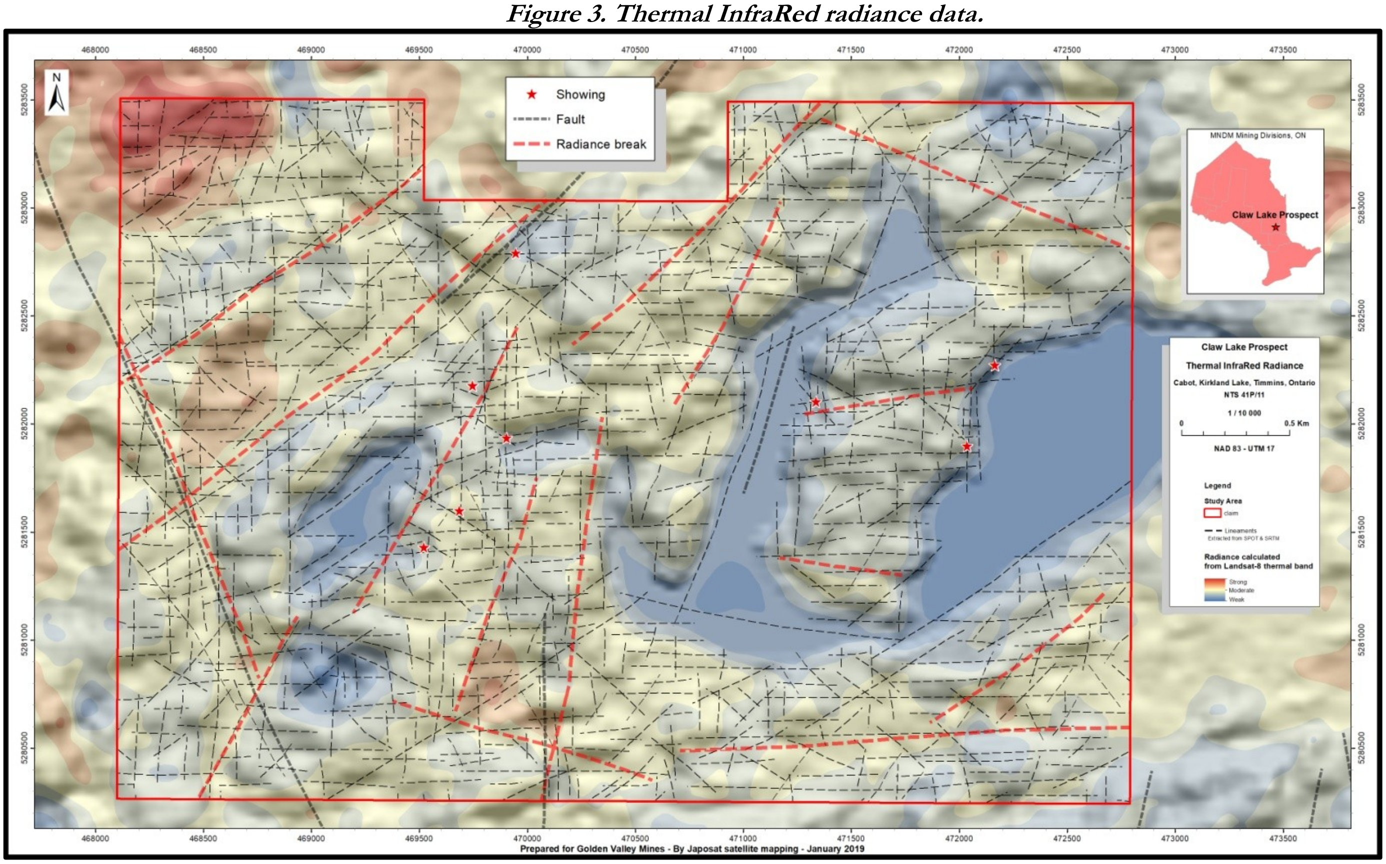

Figure 3a. Radiance break locations.

GEOBS Geobotany Signature

The GEOBS data shows many signature changes. Some of them, over the homogenous land cover areas, are marked by a break in signature, which is probably due to faults or lithological contacts (**FIG. 4**). Japosat recommends starting the investigation over the signature break areas to understand the cause of this anomalous strong GEOBS signature variation (**FIG. 4a**).

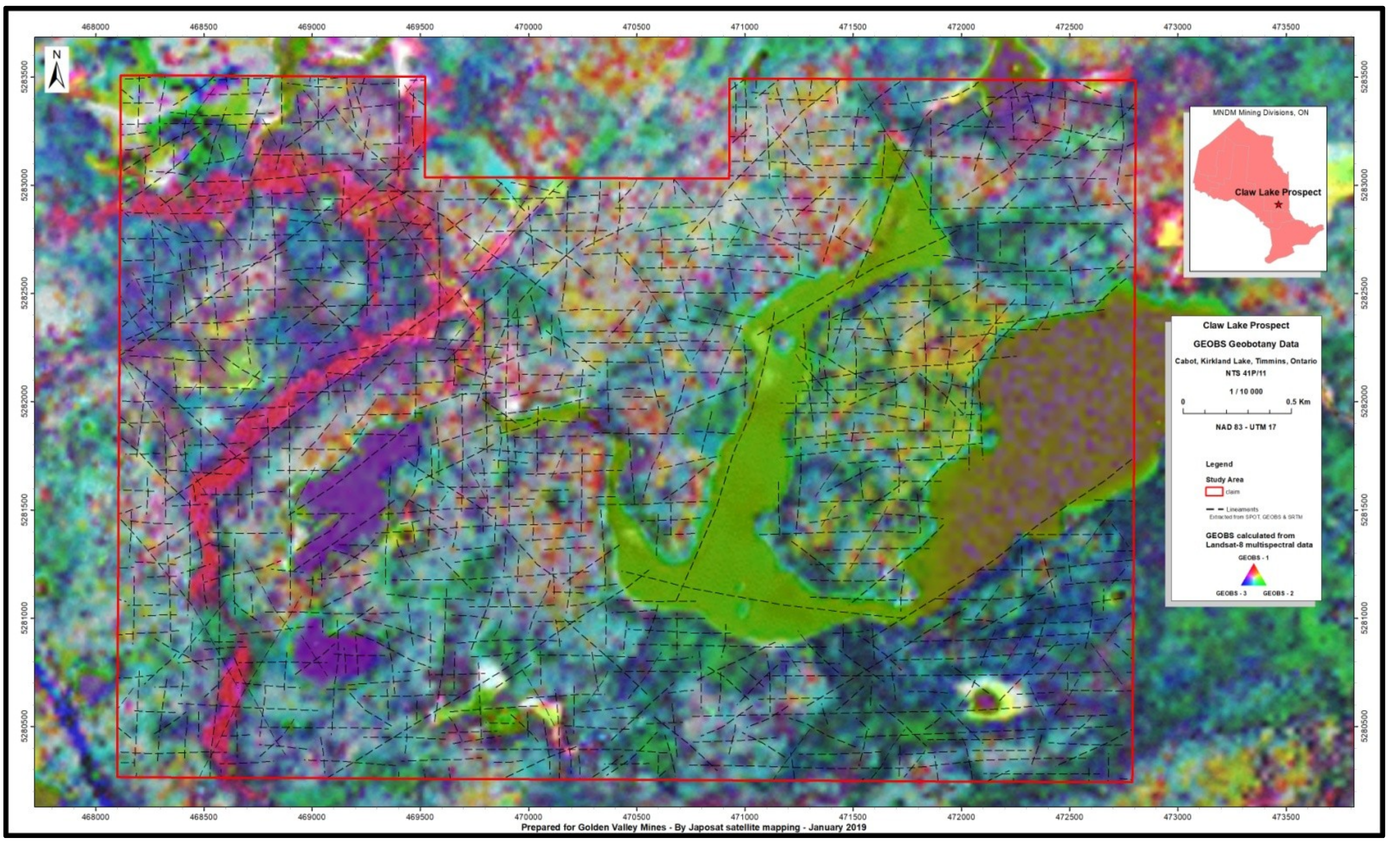

Figure 4. GEOBS geobotany data.

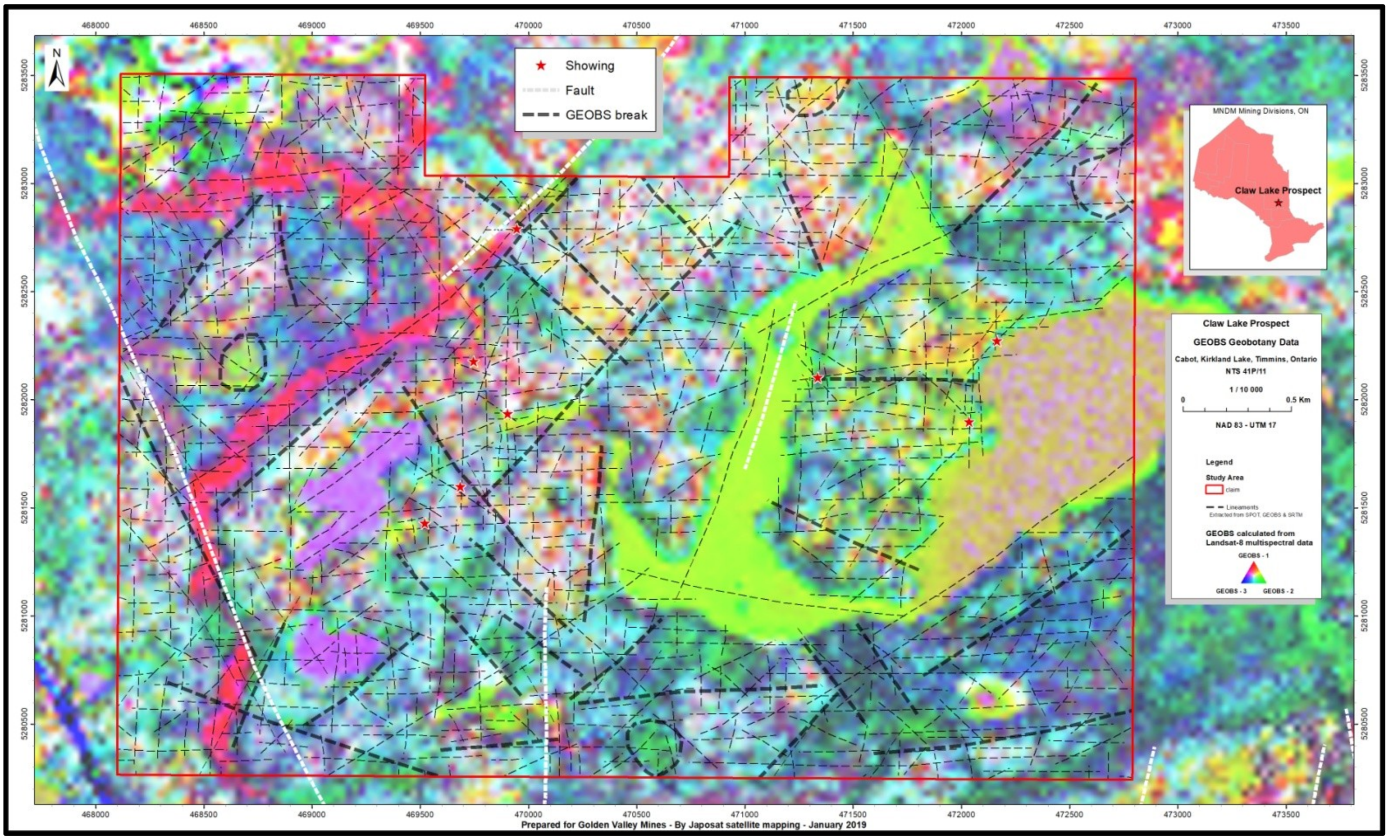

Figure 4a. GEOBS break locations.

Remote Sensing Data Compiled with Field Data

Some of the historical geology data provided to Japosat were compiled with the remote sensing study results. The outcrop lithology, showings, faults and IP survey data were compiled with the stress of lineaments (**FIG. 5**), the thermal infrared radiance data (**FIG. 6**) and GEOBS data (**FIG. 7**).

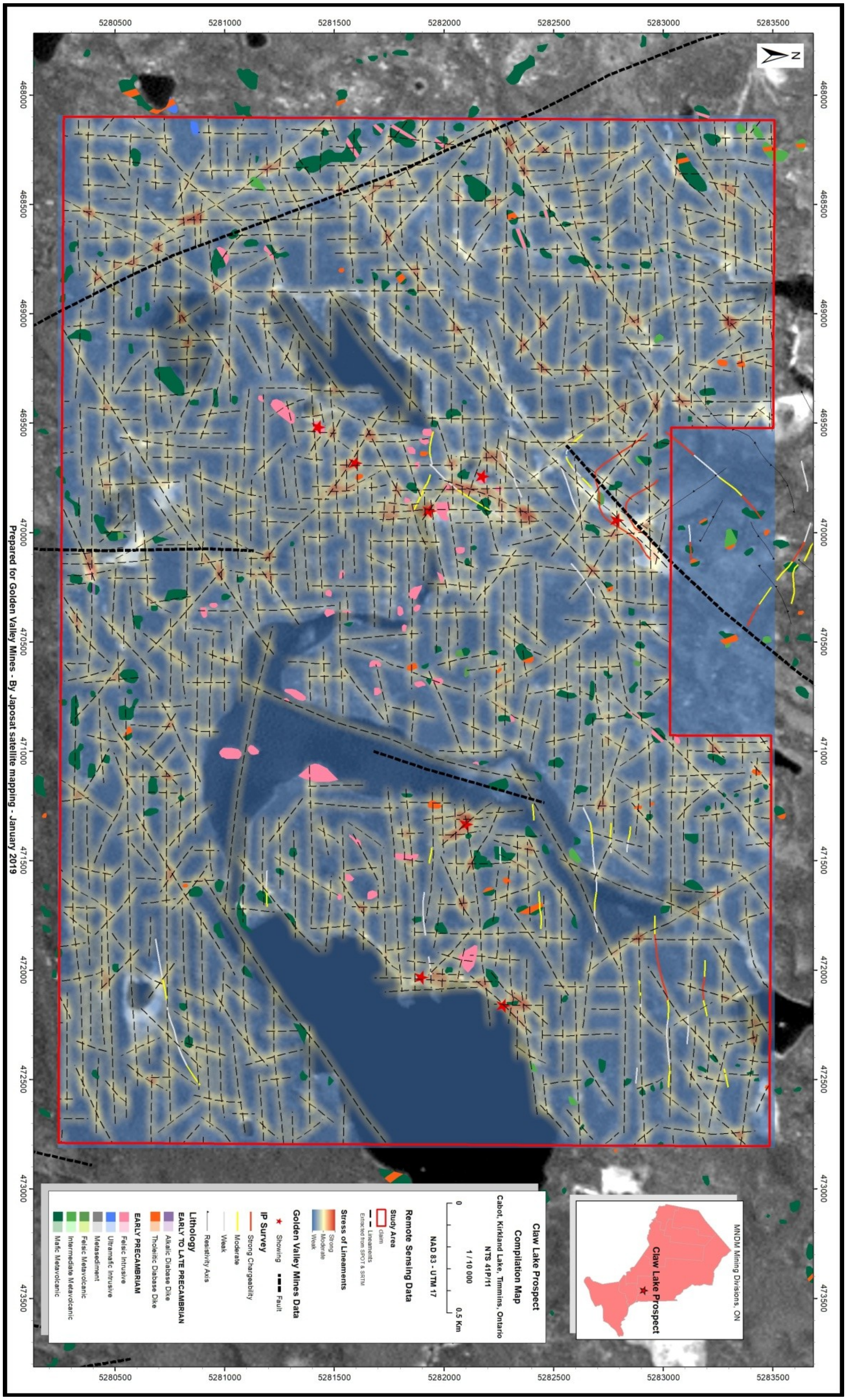

Figure 5. Compilation stress with field data.

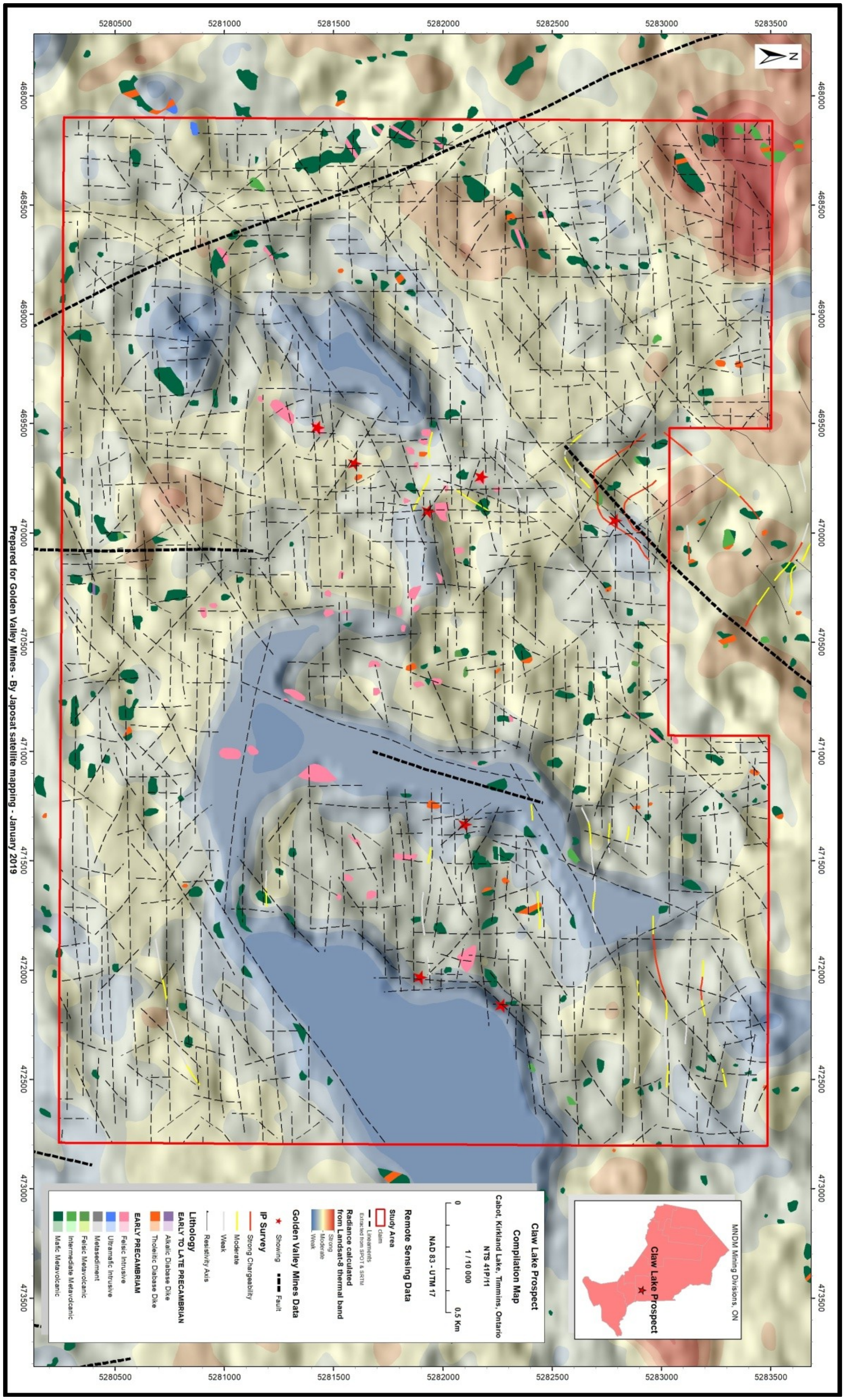

Figure 6. Compilation radiance with field data.

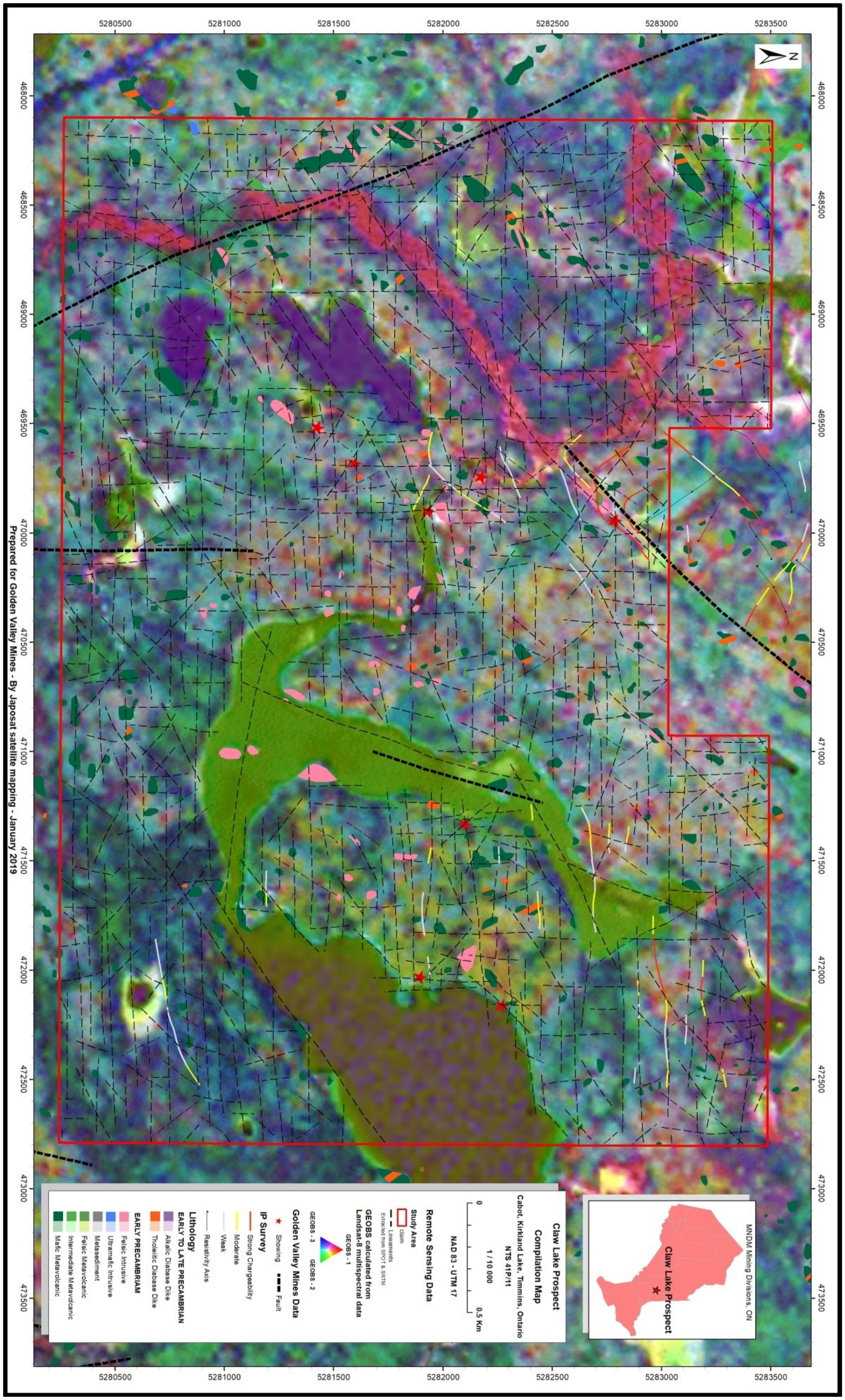

Figure 7. Compilation GEOBS with field data.

The following correlations or absence of correlations between the compiled layers of data are observed:

1. Faults previously mapped are clearly identifiable on radiance data, as well as other important lineaments. These regional structures are marked by a net break in intensity of the radiance value (abrupt linear passage from strong to moderate or weak radiance signature);
2. Known showings are mostly (7/8) associated with a weak radiance value located at or close to a moderate radiance value;
3. Outcrop lithologies are not linked to any radiance signature value;
4. Strong chargeability and resistivity axis are also not correlated to any specific radiance value. Though, both are mostly located within the moderate radiance value and are oriented in the same direction as the radiance signature;
5. All showings are associated with a lineament and most of them are located at or close to an intersection of two or more lineaments. These showings are also located within or close to a strong stress value or at the limit of a strong and a weak stress signature;
6. It is difficult to find a clear correlation between the field data and GEOBS data as the GEOBS data shows many signature changes. However, the faults previously mapped are clearly identifiable on GEOBS data, as well as other important lineaments. Some of them are marked by a break in signature due to faults or lithological contacts;
7. Chargeability and resistivity axis are in some way correlated to GEOBS signature breaks. However, as the GEOBS data is produced from a regional scale satellite data (pixel 30m), it is difficult to interpret and interpolate that correlation through the whole project area;
8. Showings are not linked to any unique GOEBS signature. Though, they are located over the small isolated single GEOBS signatures.

The key points of results / interpretation, including the location of the areas that we recommend to investigate more closely during the next field program, are illustrated in **FIG. 8**.

Conclusions and Recommendations

Japosat strongly recommends investigating all areas showing the correlations as it may lead to extend the known mineral showings. The key points of our interpretation, including the location of the areas that we recommend to investigate more closely during the next field program, are illustrated in **FIG. 8**.

We also recommend acquiring the very high resolution 40cm mono 8 bands multispectral satellite imagery and 50cm stereo satellite data, as such data, once processed, will give much more details than the coarse satellite data we have used. A new satellite tasking is needed to get this very high resolution imagery during the summer season as there is not such data available in the archives.

The approximate budget for acquiring the new very high mono and stereo satellite data, processing of data, interpretation and report is 24,000.00 CAD.

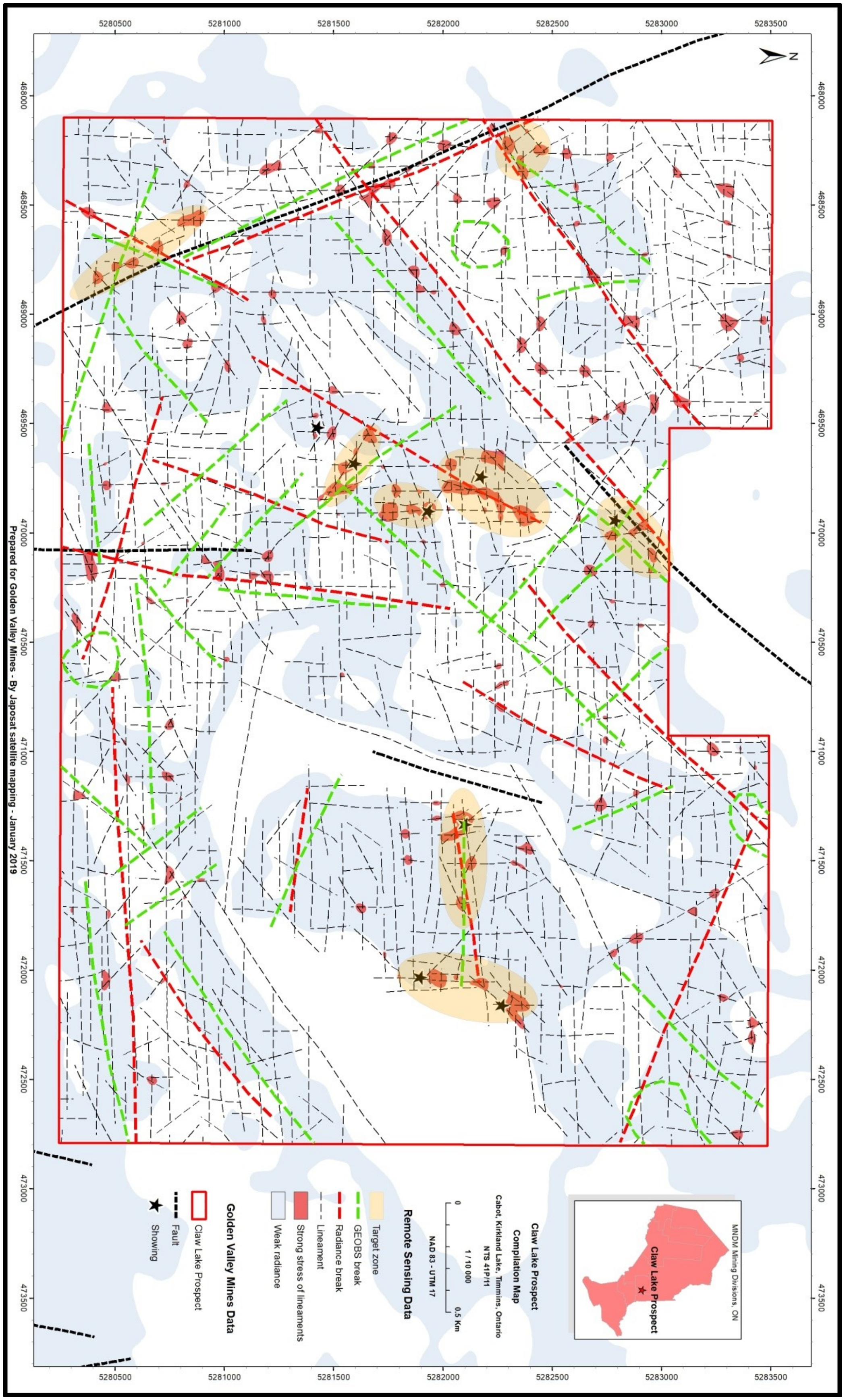

Figure 8. Compilation of results.

Delivery

The ArcGIS files, report and following maps at 10K in PDF and JPEG were delivered to Golden Valley Mines via Dropbox:

Name	Date	Type	Size
MAP 1 Linea and stress ClawLake_Prospect 2019	2019-01-16 2:42 PM	Adobe Acrobat Document	1,295 KB
MAP 1a Linea and stress ClawLake_Prospect 2019	2019-01-27 4:40 PM	Adobe Acrobat Document	1,671 KB
MAP 2 GEOBS ClawLake_Prospect 2019	2019-01-16 3:04 PM	Adobe Acrobat Document	1,494 KB
MAP 2a GEOBS ClawLake_Prospect 2019	2019-01-27 6:21 PM	Adobe Acrobat Document	2,304 KB
MAP 3 TIR Radiance ClawLake_Prospect 2019	2019-01-16 3:17 PM	Adobe Acrobat Document	902 KB
MAP 3a TIR Radiance ClawLake_Prospect 2019	2019-01-27 5:24 PM	Adobe Acrobat Document	1,635 KB
MAP 4 Location Claims ClawLake_Prospect 2019	2019-01-16 4:54 PM	Adobe Acrobat Document	1,150 KB
MAP 5 Compil RS and Geology ClawLake_Prospect 2019	2019-01-16 4:18 PM	Adobe Acrobat Document	953 KB
MAP 6 Compil RS and Geology ClawLake_Prospect 2019	2019-01-16 4:36 PM	Adobe Acrobat Document	1,346 KB
MAP 7 Compil RS and Geology ClawLake_Prospect 2019	2019-01-16 4:45 PM	Adobe Acrobat Document	1,499 KB
MAP 8 Compil RS and Geology ClawLake_Prospect 2019	2019-01-28 11:30 AM	Adobe Acrobat Document	568 KB
MAP 1 Linea and stress ClawLake_Prospect 2019	2019-01-16 2:28 PM	JPG File	4,638 KB
MAP 1a Linea and stress ClawLake_Prospect 2019	2019-01-27 4:39 PM	JPG File	4,658 KB
MAP 2 GEOBS ClawLake_Prospect 2019	2019-01-16 3:04 PM	JPG File	4,952 KB
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MAP 6 Compil RS and Geology ClawLake_Prospect 2019	2019-01-16 4:36 PM	JPG File	5,180 KB
MAP 7 Compil RS and Geology ClawLake_Prospect 2019	2019-01-16 4:44 PM	JPG File	5,232 KB
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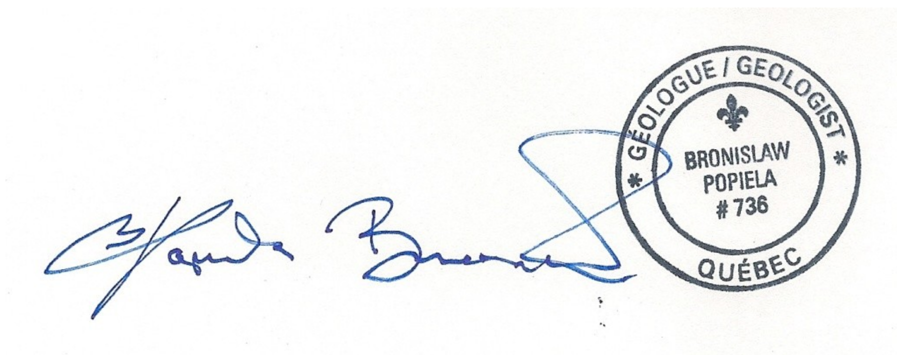
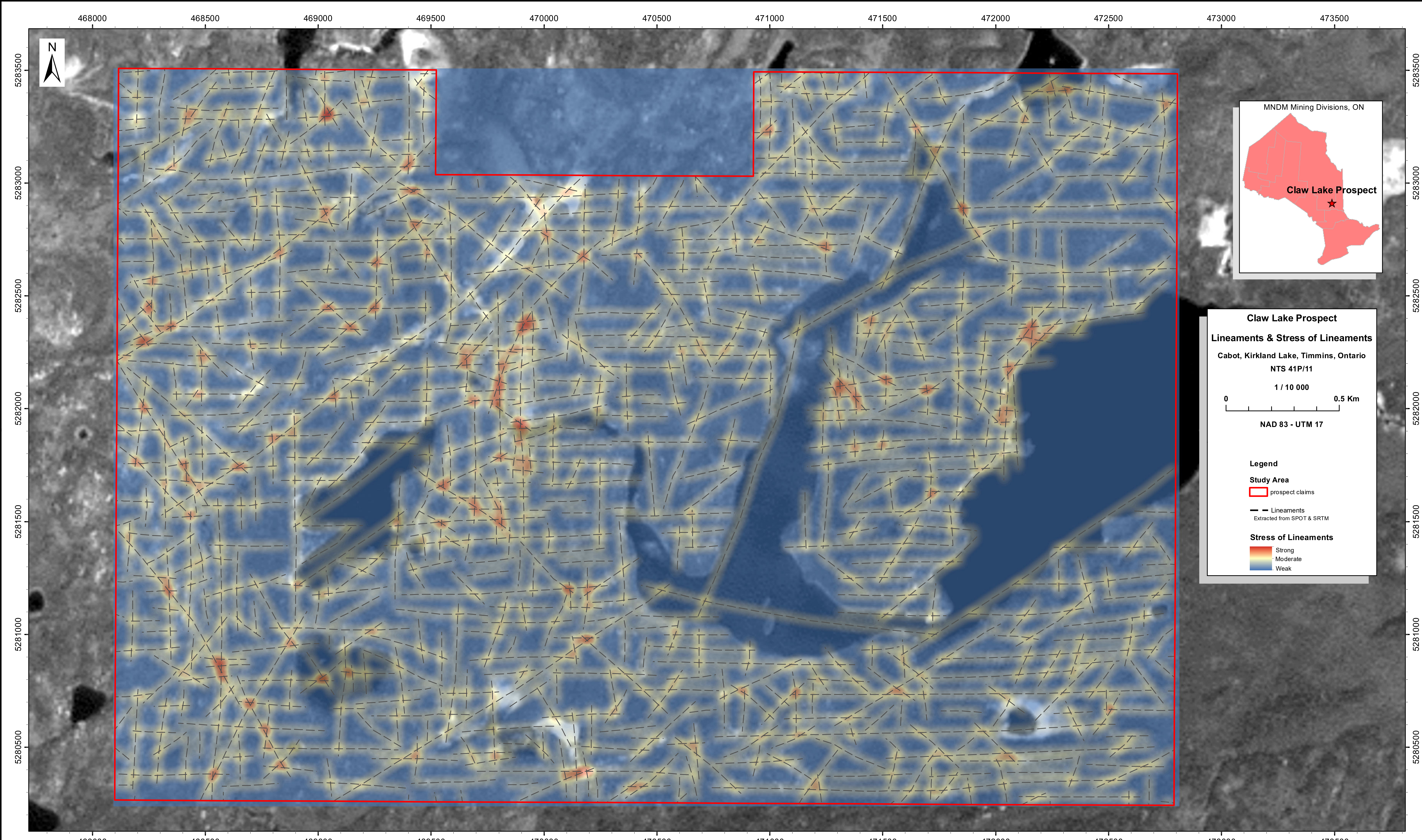
SIGNATURE

Saint-Constant, January 28th, 2019



Bronislaw Popiela, P.Geo., M.Sc., (OGQ #736)
Member of l'Association Québécoise de Télédétection



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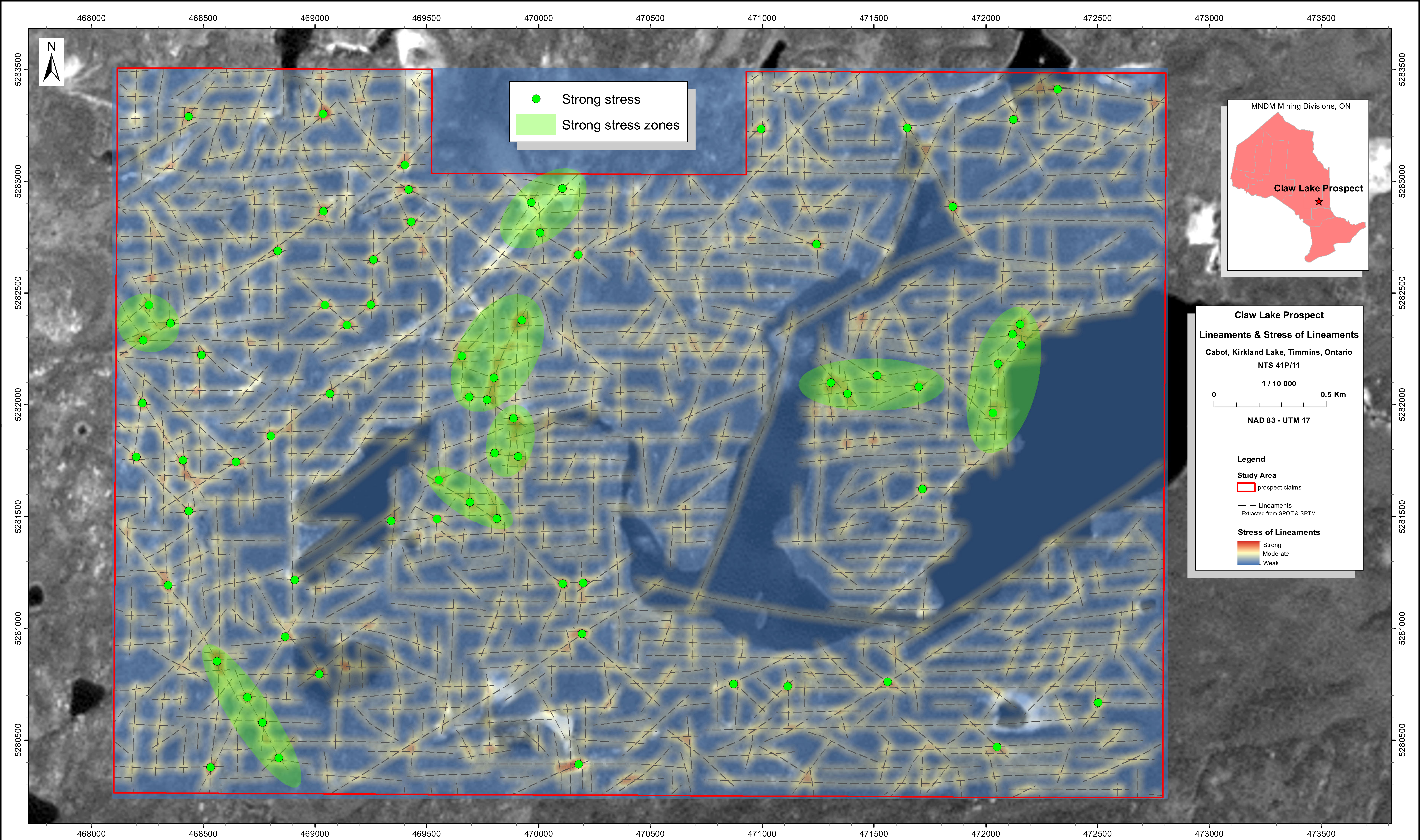

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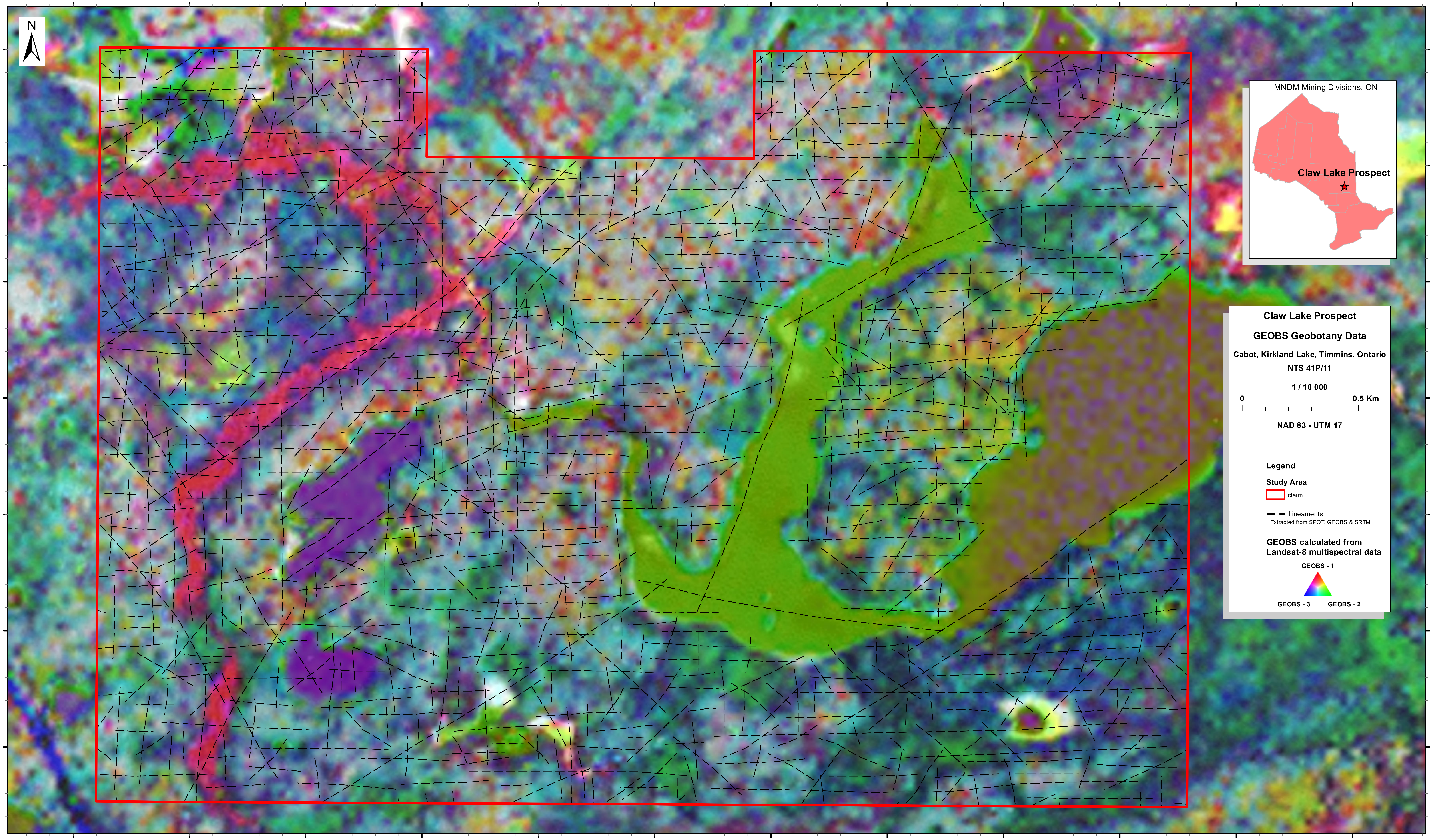

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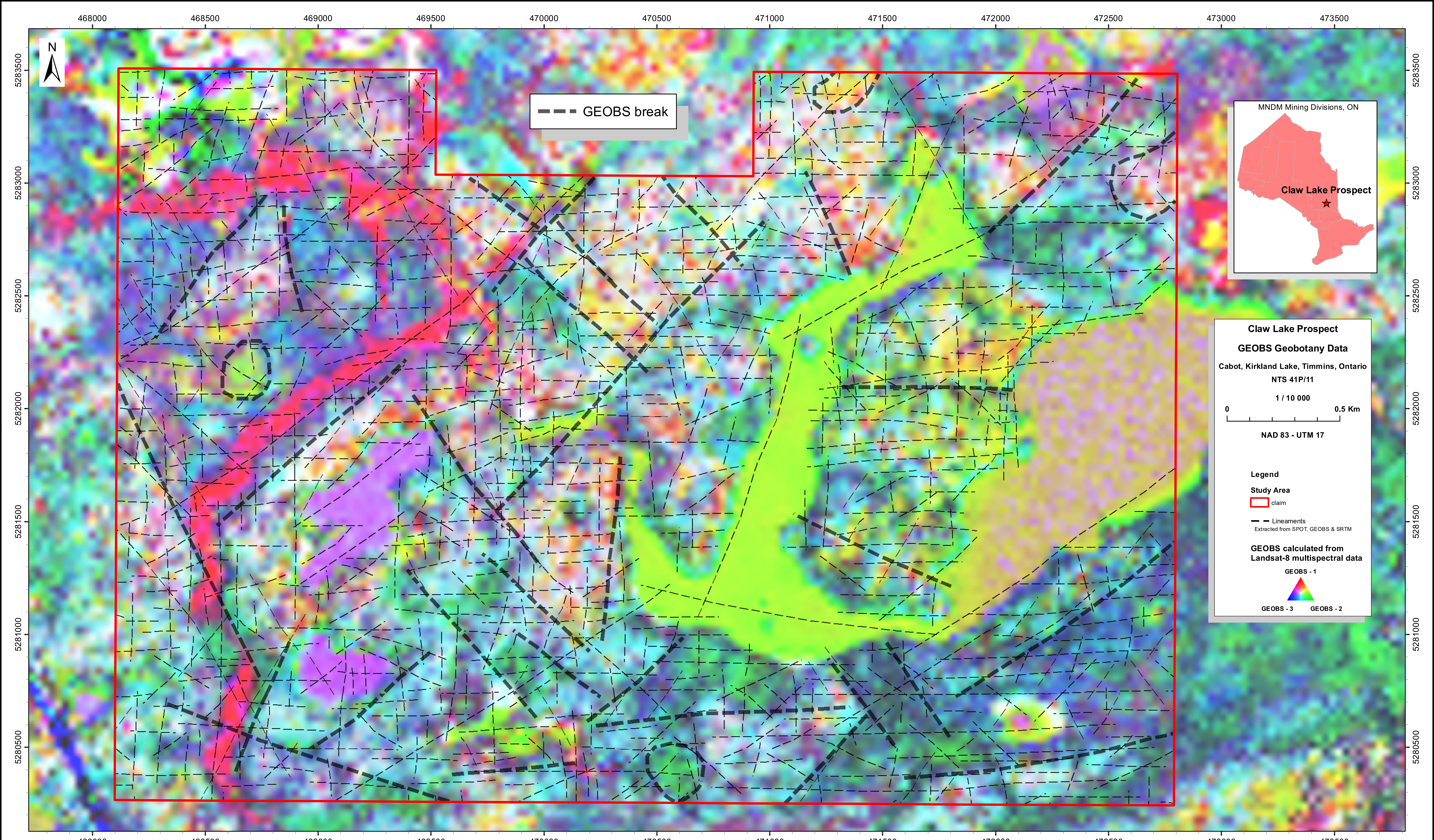

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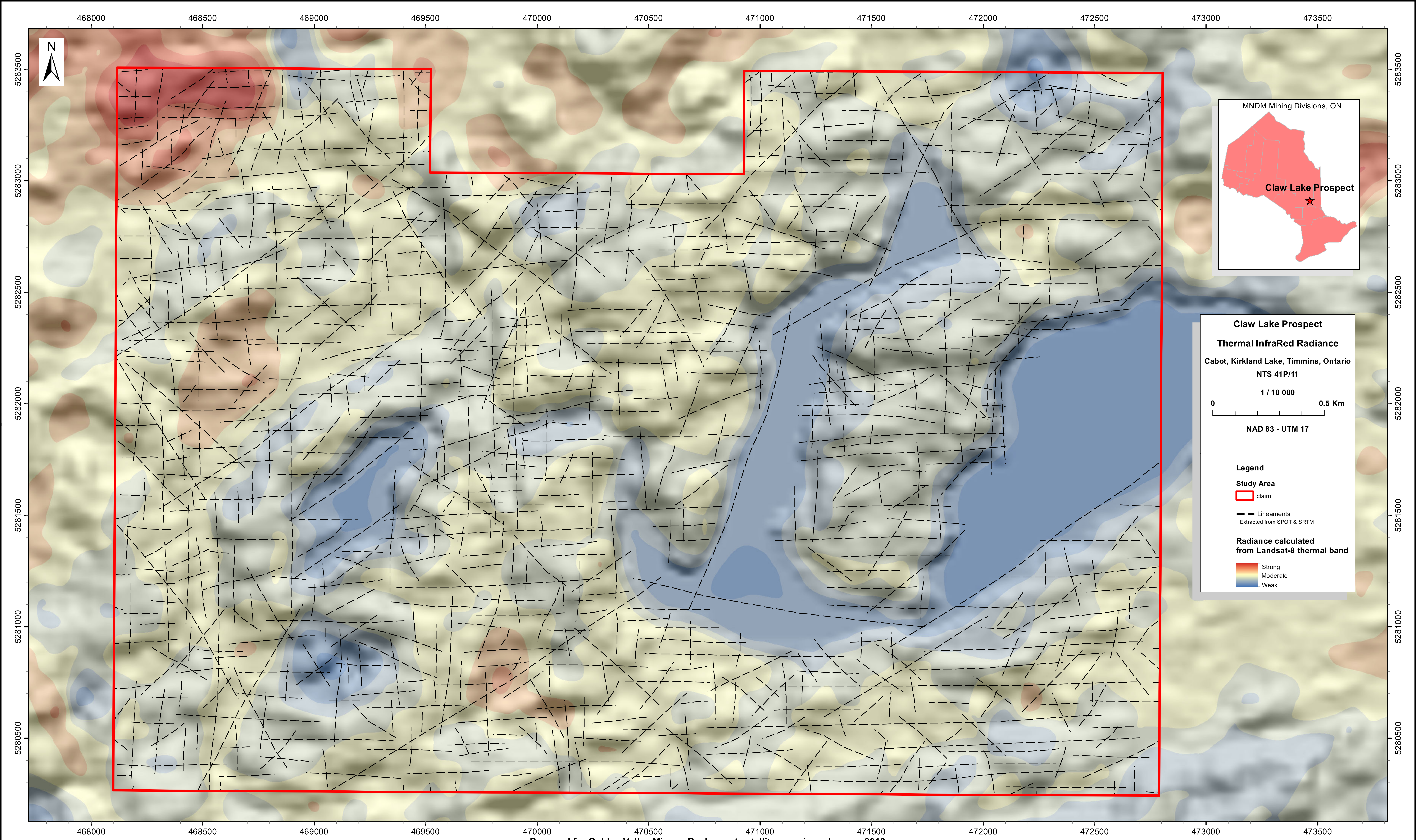

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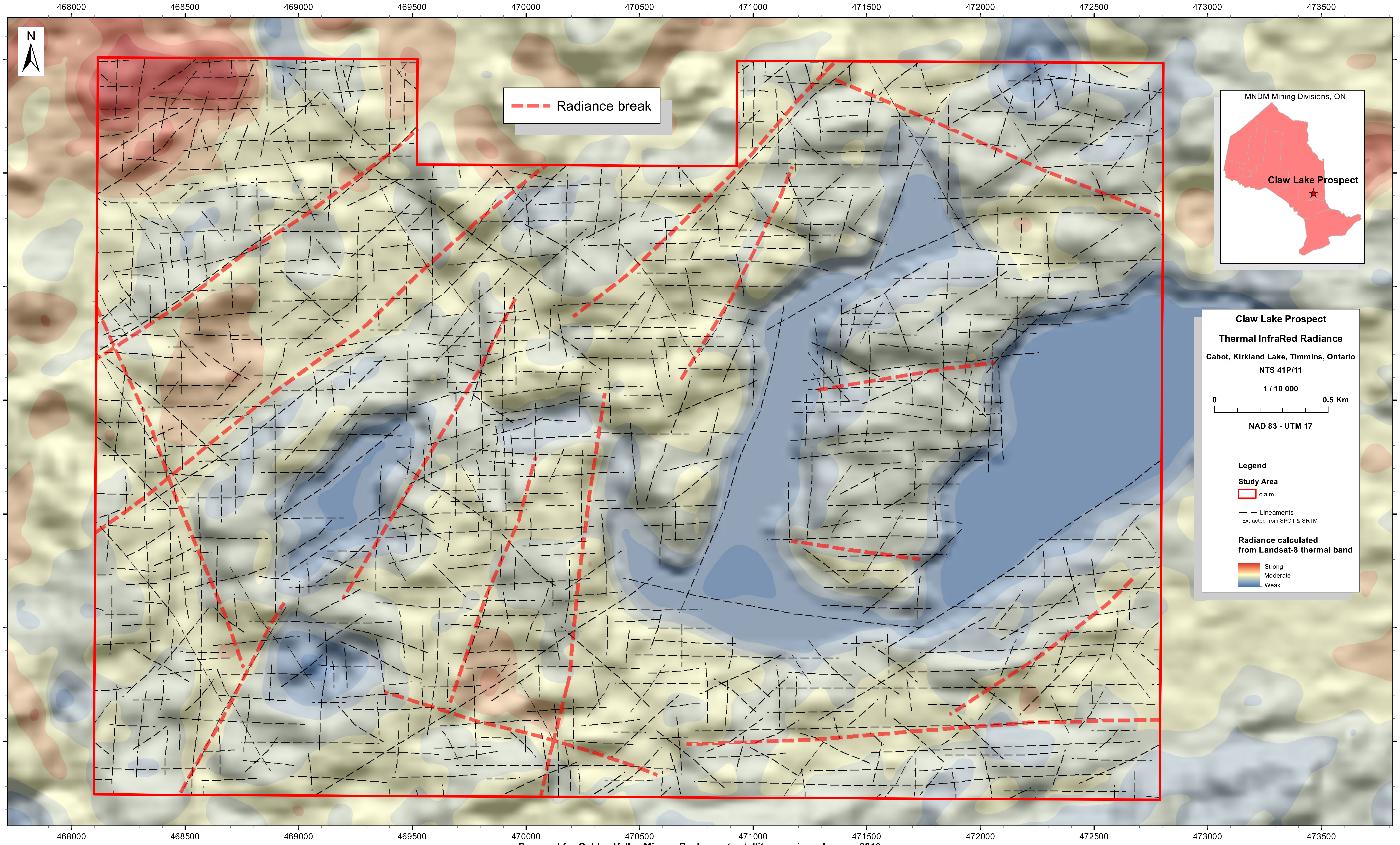

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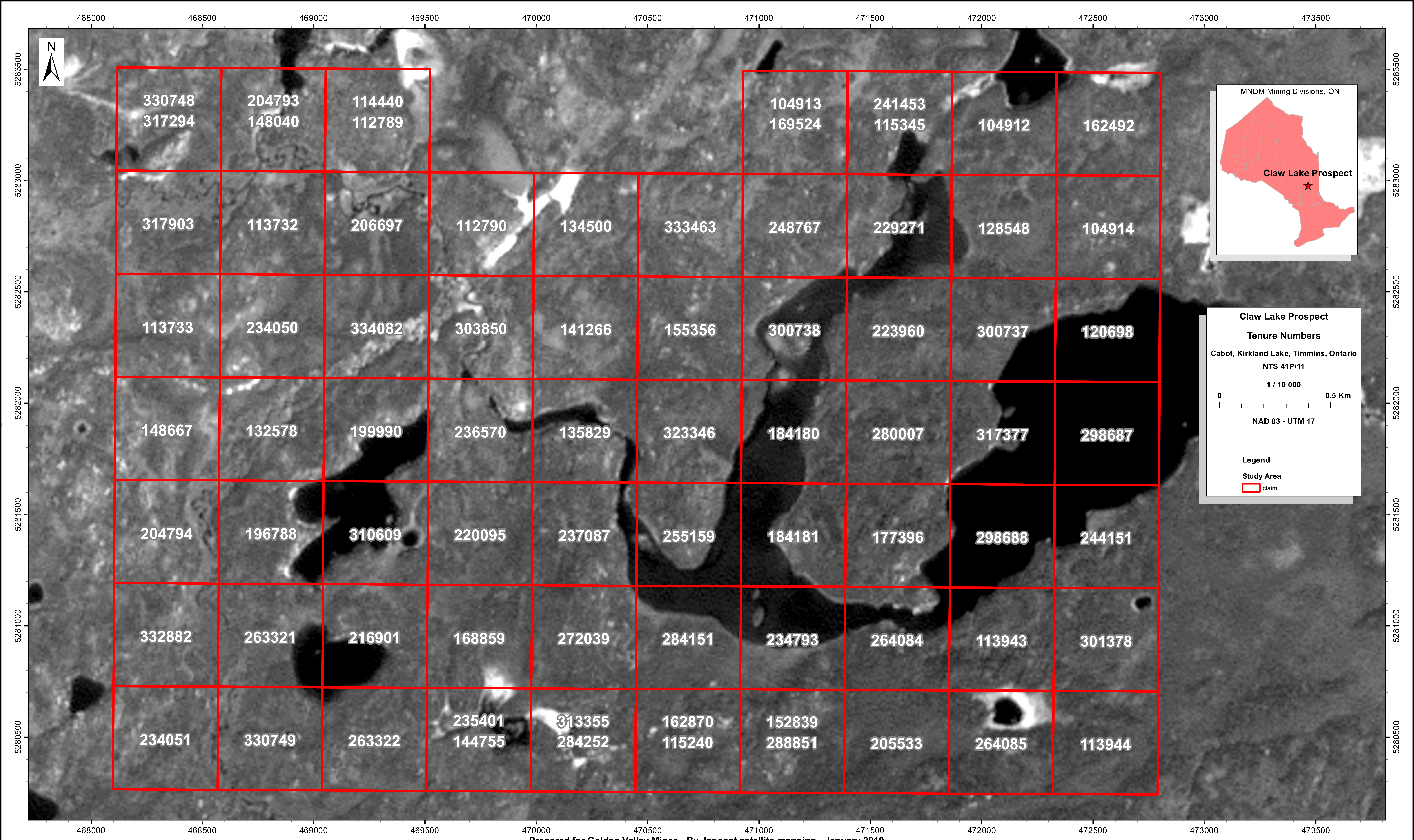

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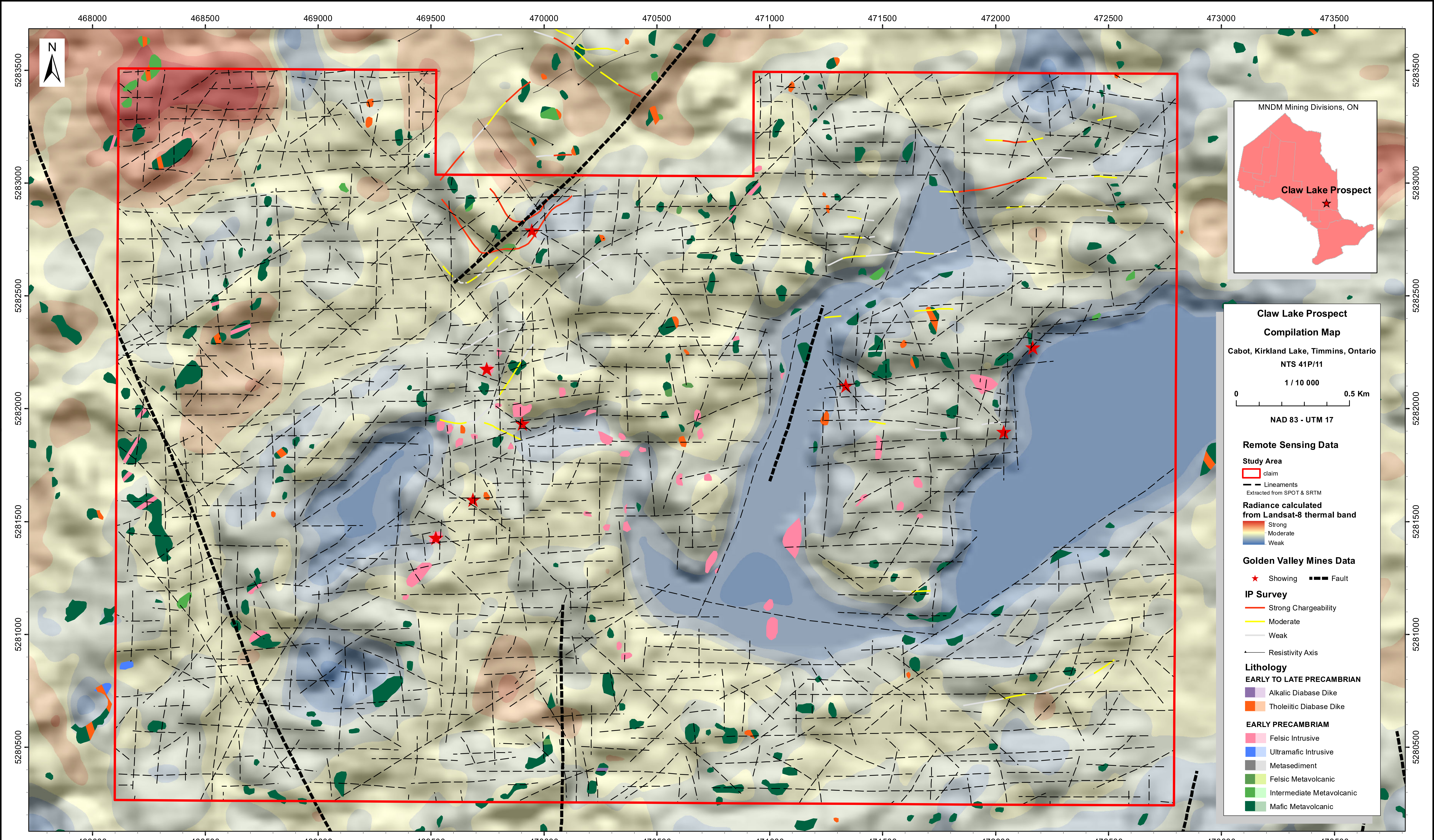

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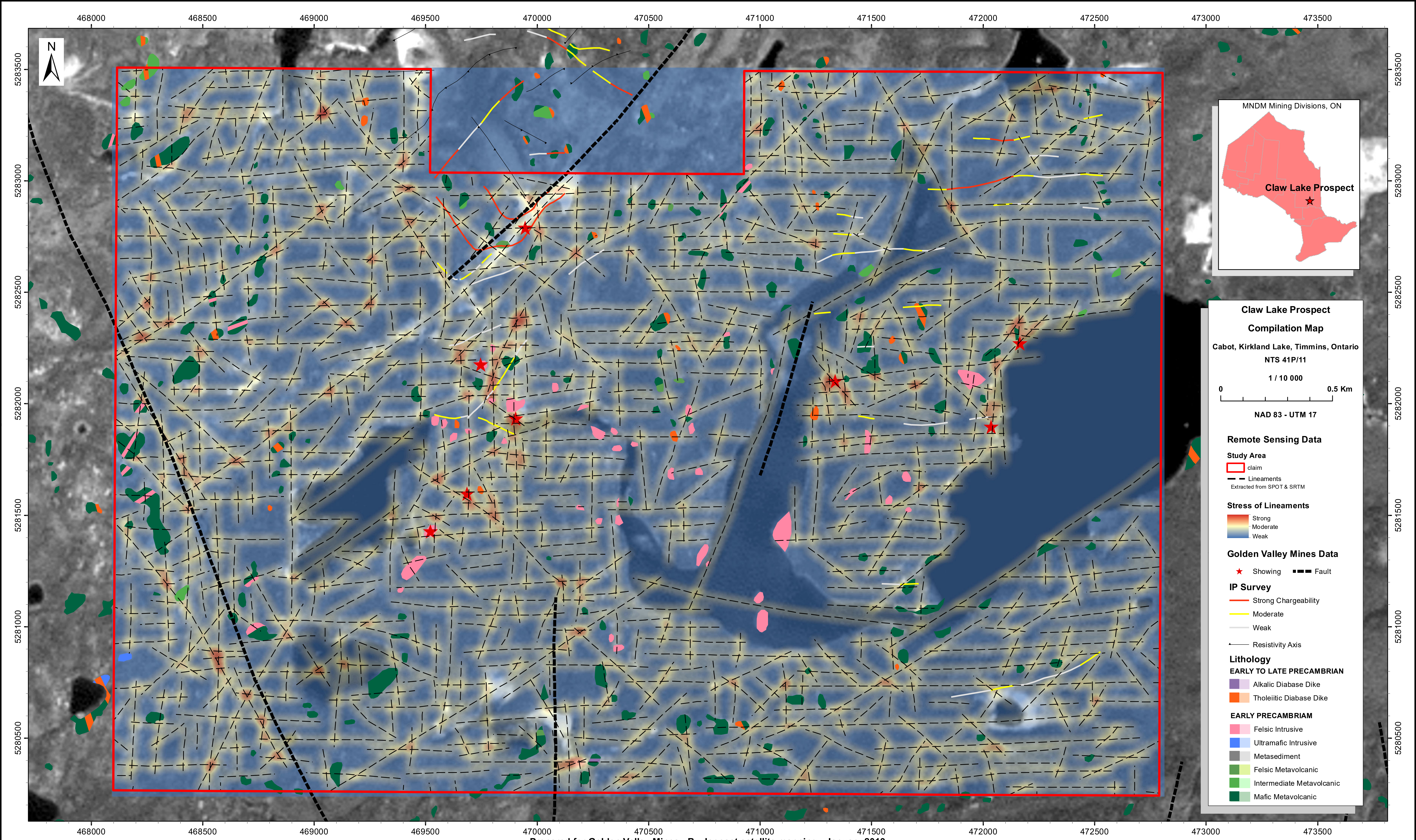

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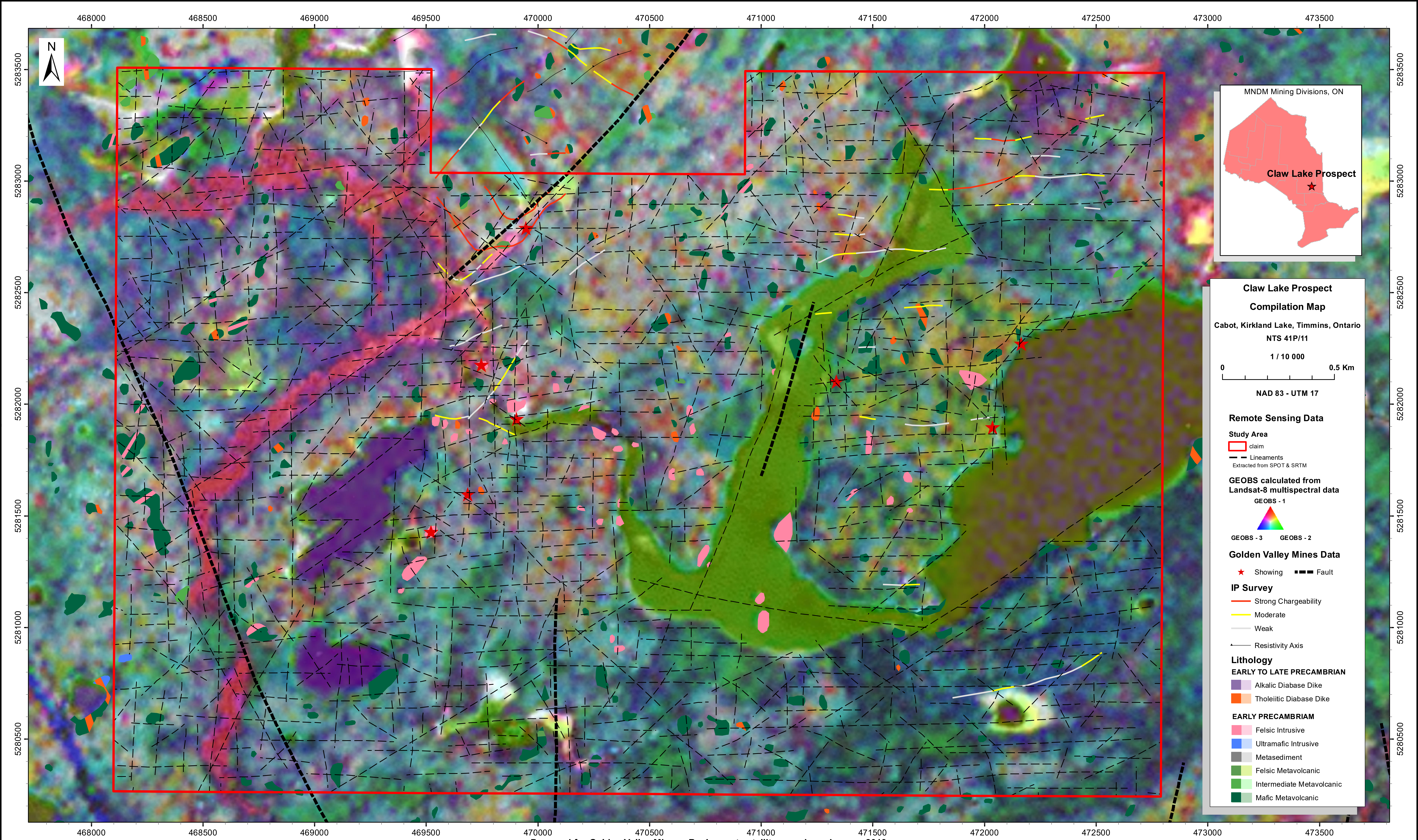

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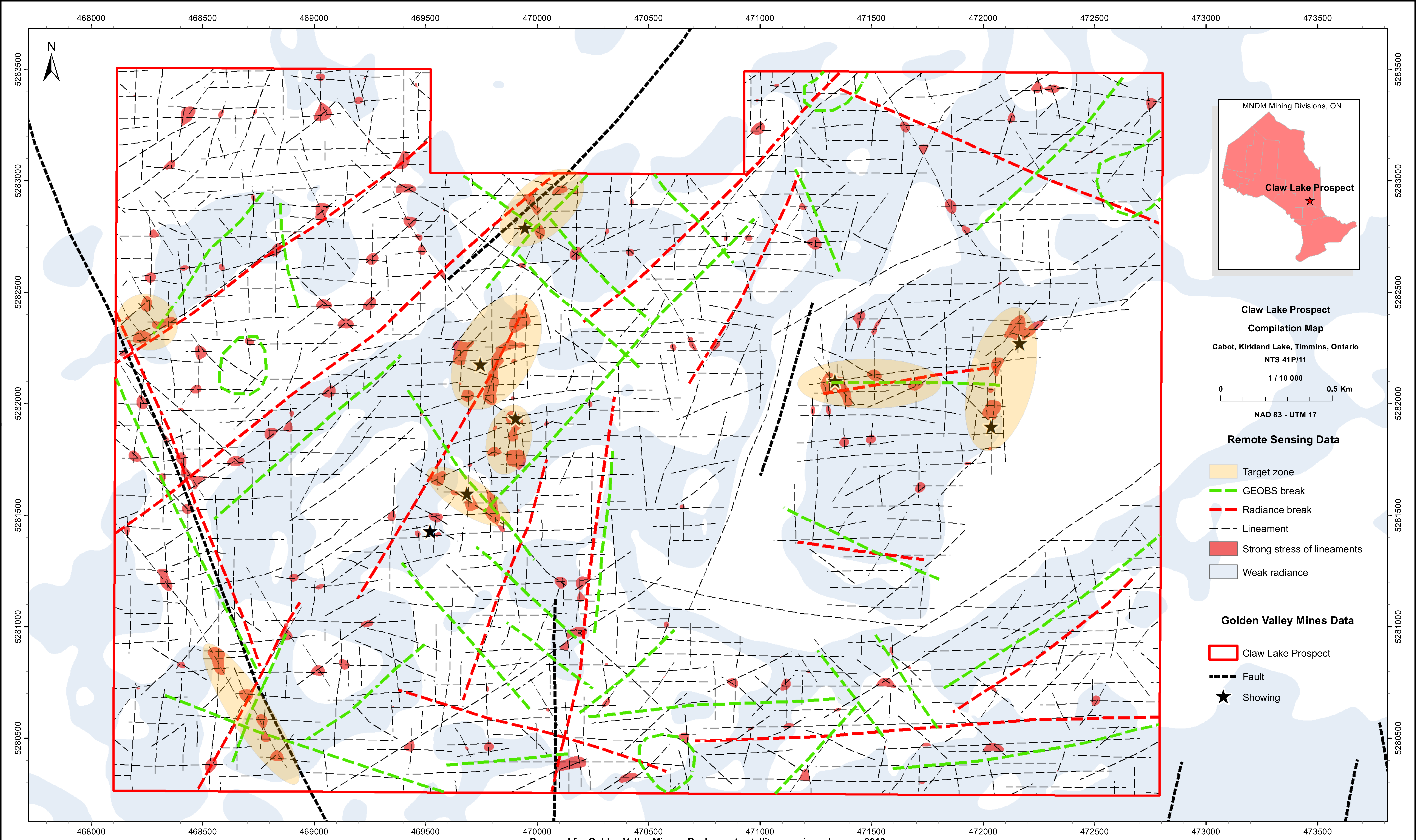

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