

Technical Presentation
Geoscience BC Report 2015-15

Technical Presentation for the file "QUEST_Analysis_2015_015.mpk"
Interpretation and Analysis of Magnetic and Gravity Datasets

M.G. Sánchez, T. Bissig and P. Kowalczyk

Prepared for



By

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Date: 29th of April 2015

**Technical Presentation for the file "QUEST_Analysis_2015_015.mpk"
Interpretation Map of Magnetic and Gravity Datasets,
QUEST Area, Central British Columbia**



Summary

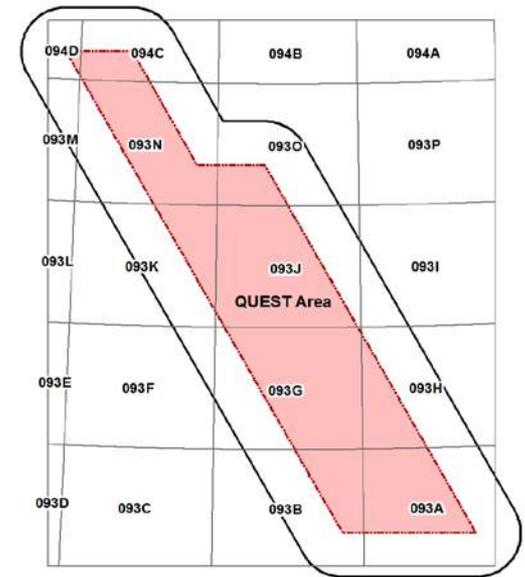
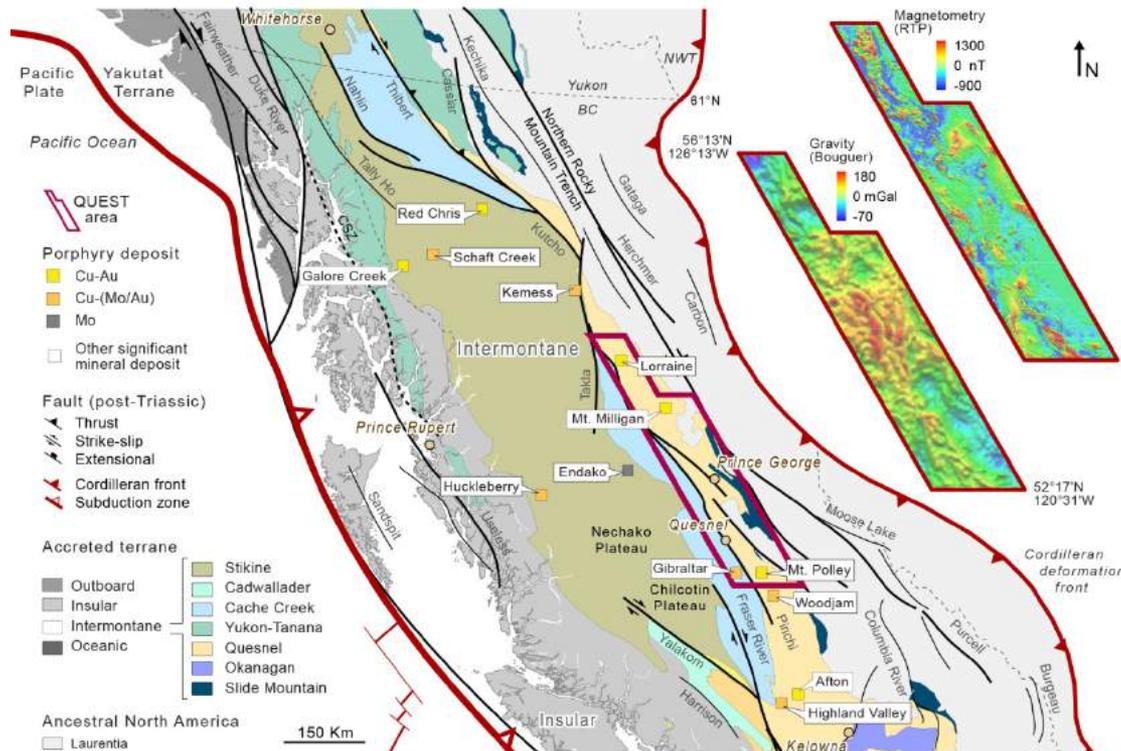
This technical report includes a detailed description of the datasets, methodologies and interpretation layers included with the ArcGIS Map Package file "QUEST_Analysis_2015_015.mpk".

This structural and geological interpretation of magnetic and gravity datasets provides a detailed look at the bedrock geology and structural architecture across the QUEST project area at a scale of 1 : 400.000.

This map is intended to contribute to a better understanding of BC's geology and to be used as a base layer for the exploration for porphyry-style deposits across the highly prospective QUEST area.

Interpretation and Analysis of Magnetic and Gravity Datasets, QUEST Area, Central British Columbia

(NTS SHEETS 093A, B; 093F - K, 093M - O; 094C, D)



Prepared for



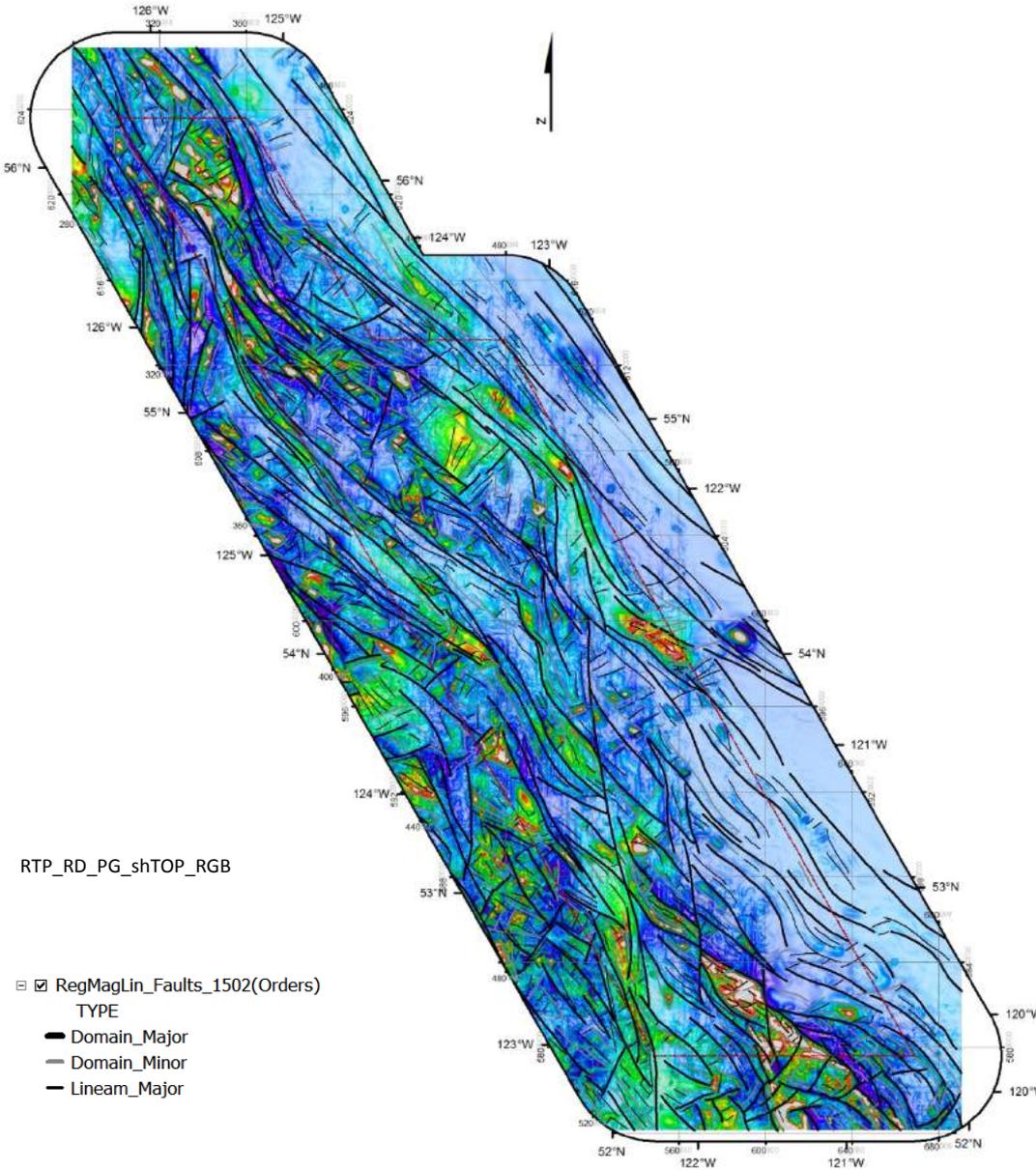
Toward an improved basis for beneath-cover mineral exploration in the QUEST area:
New structural interpretation of geophysical and geological datasets
(NTS SHEETS 093A, B; 093F - K, 093M - O; 094C, D)

**Interpretation and Analysis of Magnetic and Gravity Datasets,
QUEST Area, Central British Columbia**

M.G. Sánchez, T. Bissig and P. Kowalczyk

Universal Transverse Mercator Projection, Zone 10
North American Datum 1983

April 30, 2015



RTP_RD_PG_shTOP_RGB

RegMagLin_Faults_1502(Orders)

TYPE

— Domain_Major

— Domain_Minor

- - Lineam_Major

Acknowledgements

The authors thank Geoscience BC and the Provincial Government of British Columbia for supporting and funding this project.

The geological data on this map has been extracted from the British Columbia Geology Survey (BCGS) Open File 2013-04 map (Cui et al. 2013), which source data was originally released in 2005 (Massey et al., 2005). This study uses Geoscience BC's airborne gravity grid and NRC's aeromagnetic grids (Geoscience BC, 2009a, b), SRTM30x3 digital elevation model (Fair et al., 2007), the BCGS MINFILE database (BC Geological Survey, 2014) and BCGS cartographic information (GeoFile 2005-1).

References

BC Geological Survey (2014): MINFILE BC mineral deposits database; BC Ministry of Energy and Mines, BC Geological Survey, URL <<http://minfile.ca/>> [March 2015].

Cui, Y., Katay F, Nelson, J.L., Han, T., Desjardins, P.J. and Sinclair, L. (2013): BCGS Regional Bedrock Geology Map, BCGS Open File 2013-04.

GeoFile 2005-1: Digital Geology Map of British Columbia: Whole Province, B.C. Ministry of Energy and Mines, GeoFile 2005-1, by N.W.D. Massey, D.G. MacIntyre, P.J. Desjardins and R.T. Cooney, URL <<http://www.empr.gov.bc.ca/MINING/GEOSCIENCE/PUBLICATIONSCATALOGUE/DIGITALGEOLOGYMAPS/>> [March 2015].

Geoscience BC (2009a): QUEST project compilation maps; Geoscience BC, Report 2009-4, URL <<http://www.geosciencebc.com/s/2009-04.asp>> [March 2015].

Geoscience BC (2009b): QUEST project – geology; Geoscience BC, Map 2009-4-1, scale 1:500,000, URL <http://www.geosciencebc.com/i/project_data/QUESTdata/GBC_Report2009-4/map_2009_4_1_geo.pdf> [March 2015].

Massey, N.W.D., MacIntyre, D.G., Desjardins, P.J. and Cooney, R.T. (2005): Digital Geology Map of British Columbia: Whole Province; B.C. Ministry of Energy and Mines, GeoFile 2005-1, scale 1:250,000.

Sánchez, M.G., Bissig, T. and Kowalczyk, P. (2015): Toward an improved basis for beneath-cover mineral exploration in the QUEST area, central British Columbia: new structural interpretation of geophysical and geological datasets (NTS 093A, B, G, H, J, K, N); in Geoscience BC Summary of Activities 2014, Geoscience BC, Report 2015-1, p. 53-62.

**Technical Presentation for the file "QUEST_InterpMap_2015_015.mpk"
Interpretation and Analysis of Magnetic and Gravity Datasets,
QUEST Area, Central British Columbia**

Contents

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1. Introduction and datasets
2. Anomaly axis of RTP aeromagnetic anomalies
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6. Structural interpretation of aeromagnetic lineaments
7. Summary interpretation map

Contents numbering follows interpretation workflow and are kept in QUEST_Analysis_2015_015.mpk Map Package file for guidance

Prepared for



Interpretation and Analysis of Magnetic and Gravity Datasets, QUEST Area, Central British Columbia



1. Introduction and Datasets

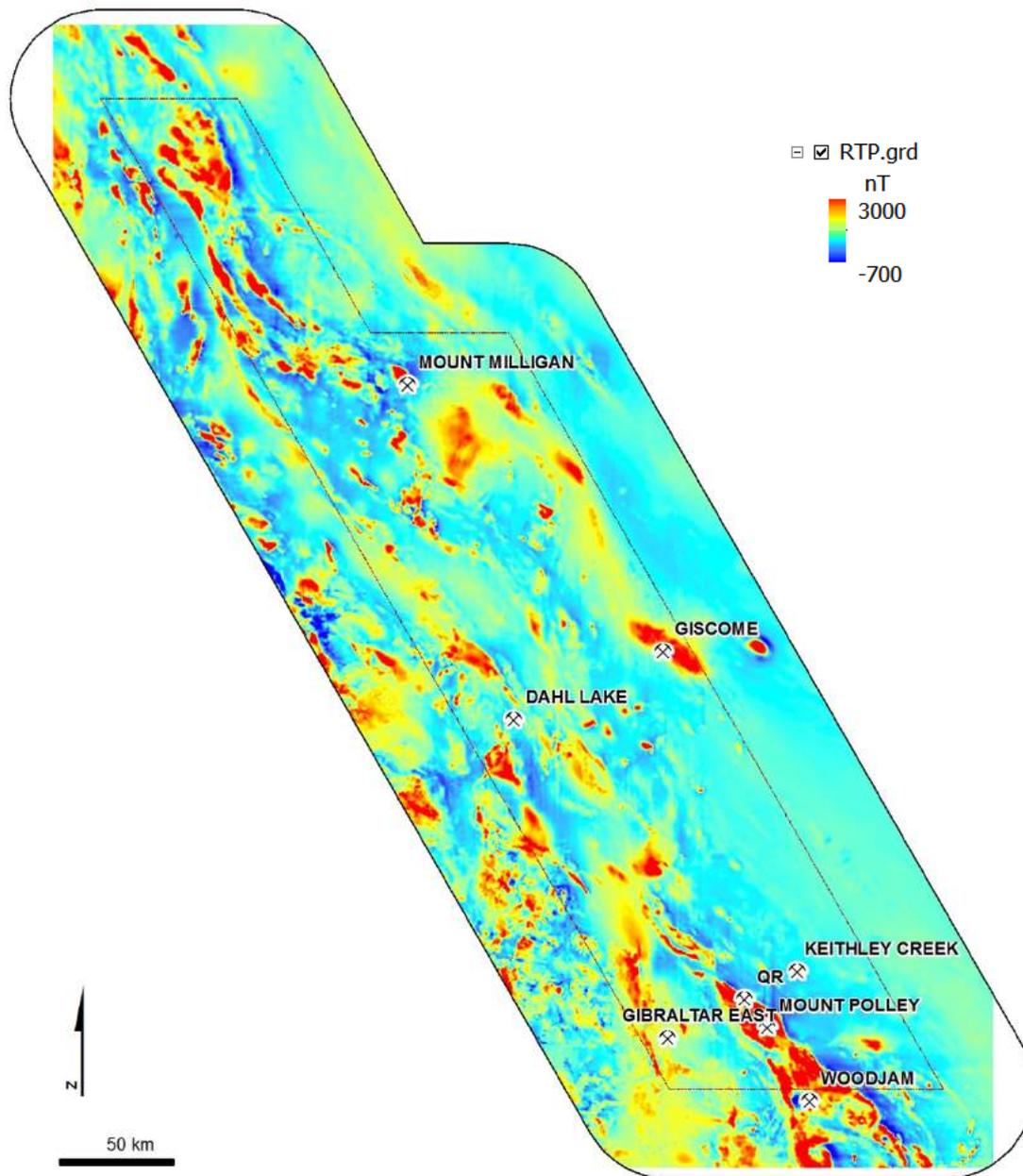
Geoscience BC's QUEST survey area in central British Columbia is generally prospective for porphyry Cu-Au mineralization beneath covering glacial drift. The area has a large amount of regional geophysical and geochemical data, however, the bedrock geology remains poorly constrained.

This project aims to improve the interpretation of :

- Geoscience BC's airborne gravity grid
- Natural Resources Canada's (NRCan) regional reduced-to-pole (RTP) aeromagnetic data

Additional data utilized in this project includes:

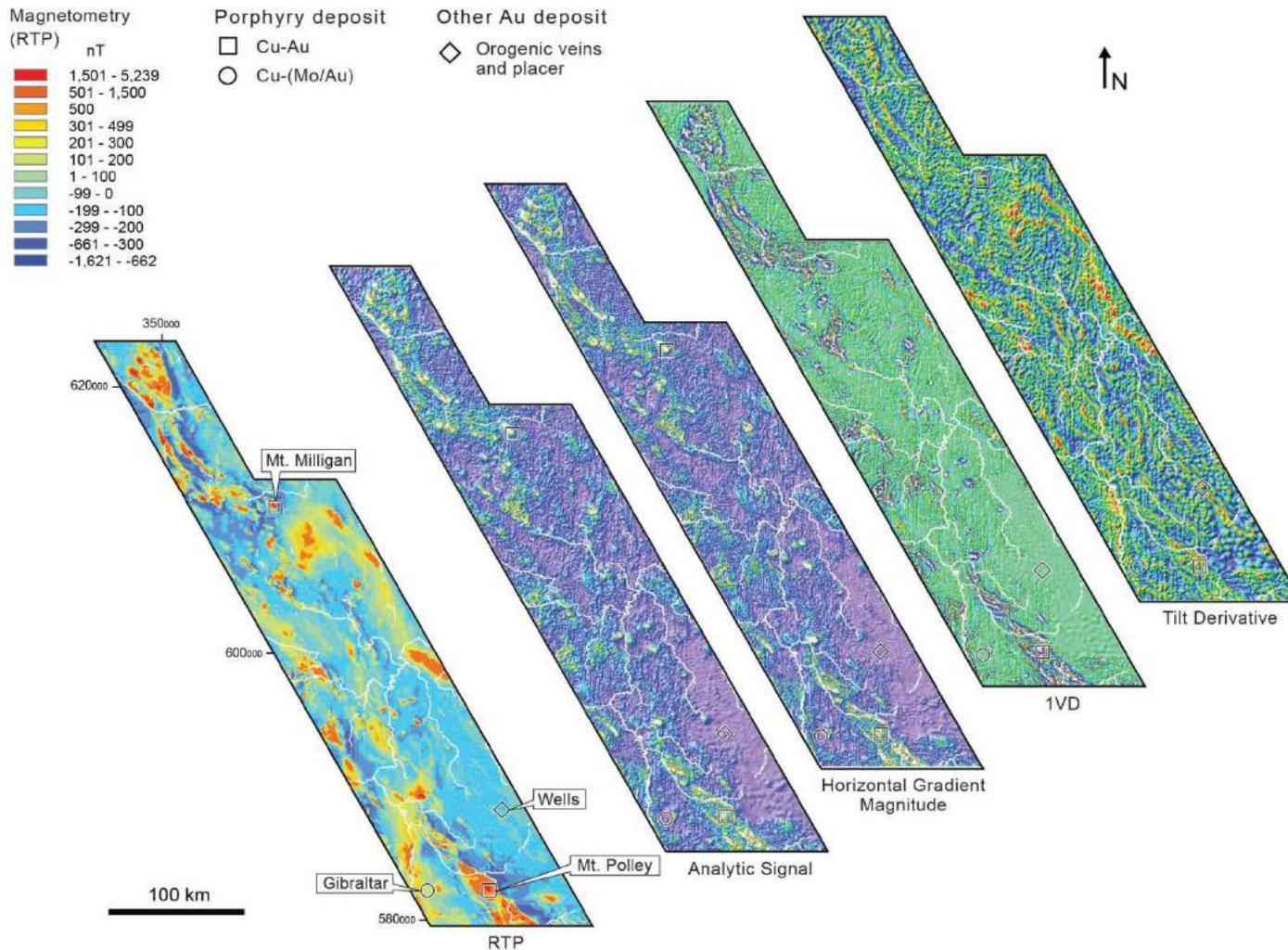
- The BCGS Open File 2013-04 map (Cui et al. 2013), which source data was originally released in 2005 (Massey et al., 2005)
- Satellite-derived Shuttle Radar Topography Mission (SRTM) digital elevation model
- The BCGS MINFILE database (BC Geological Survey, 2014)



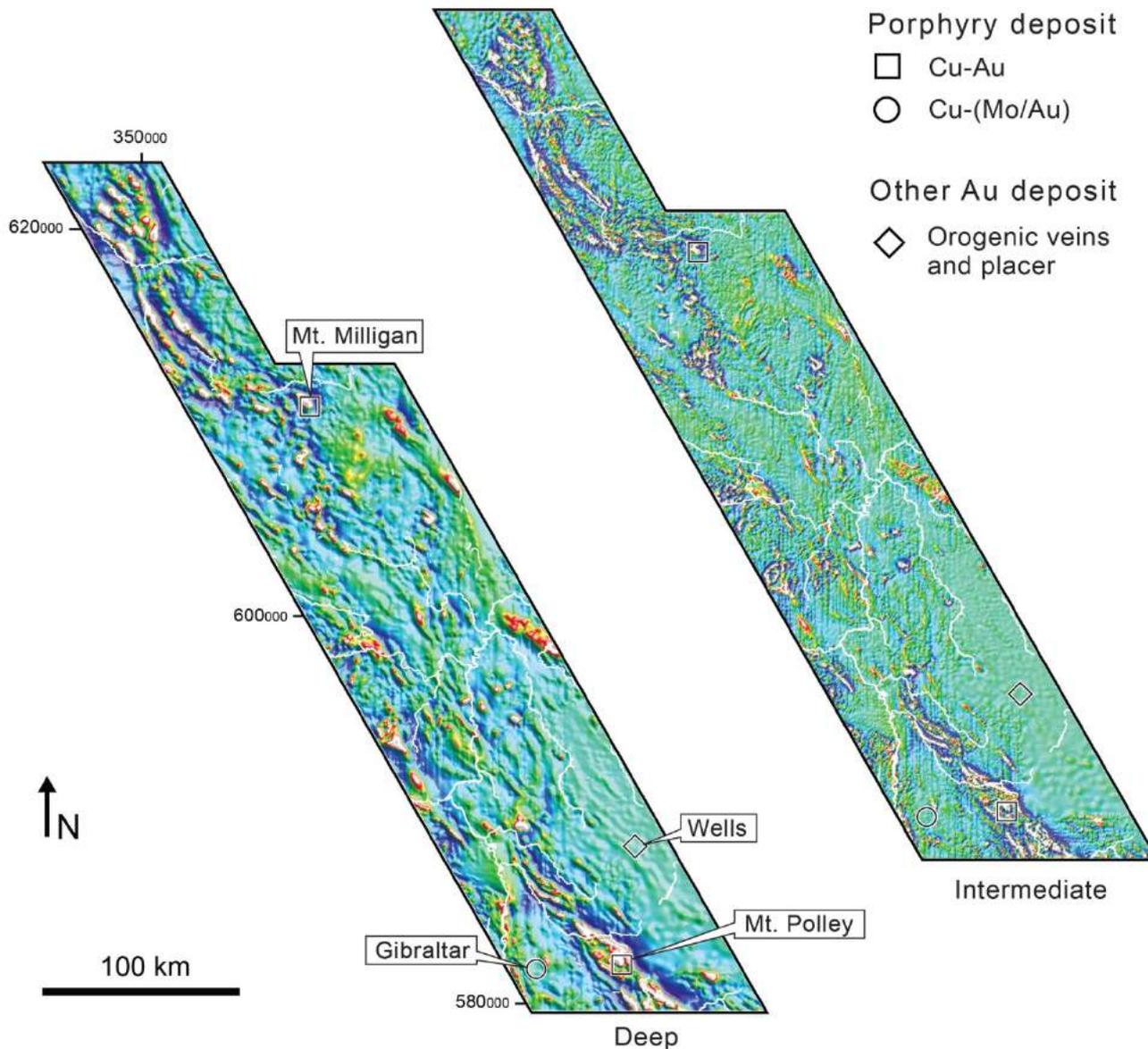
Aeromagnetic data used as base layer for Interpretation

- The NRCan's RTP aeromagnetic grid was used as a base layer for structural and geological interpretation
- A series of filters and transformations applied to the RTP aeromagnetic and IR gravity grids have been used for interpretation and analysis
- The interpretation area includes a 40 km buffer zone surrounding the QUEST area

High-Pass Filters and Transformations



- High-pass filters were used to suppress deep, long-wavelength signals and to accentuate the near-surface responses that are useful for structural interpretation
- The analytic signal (AS) and the horizontal-gradient magnitude (HGM) grids were used to detect magnetic- and gravity-anomaly boundaries as both filters place their 'peak' amplitude over edges or geological contacts
- The 1VD grid and the tilt-derivative (TD) filter were effective in accentuating the high-frequency signals that commonly arise from linear features such as faults, fractures, stratification, foliation and dikes

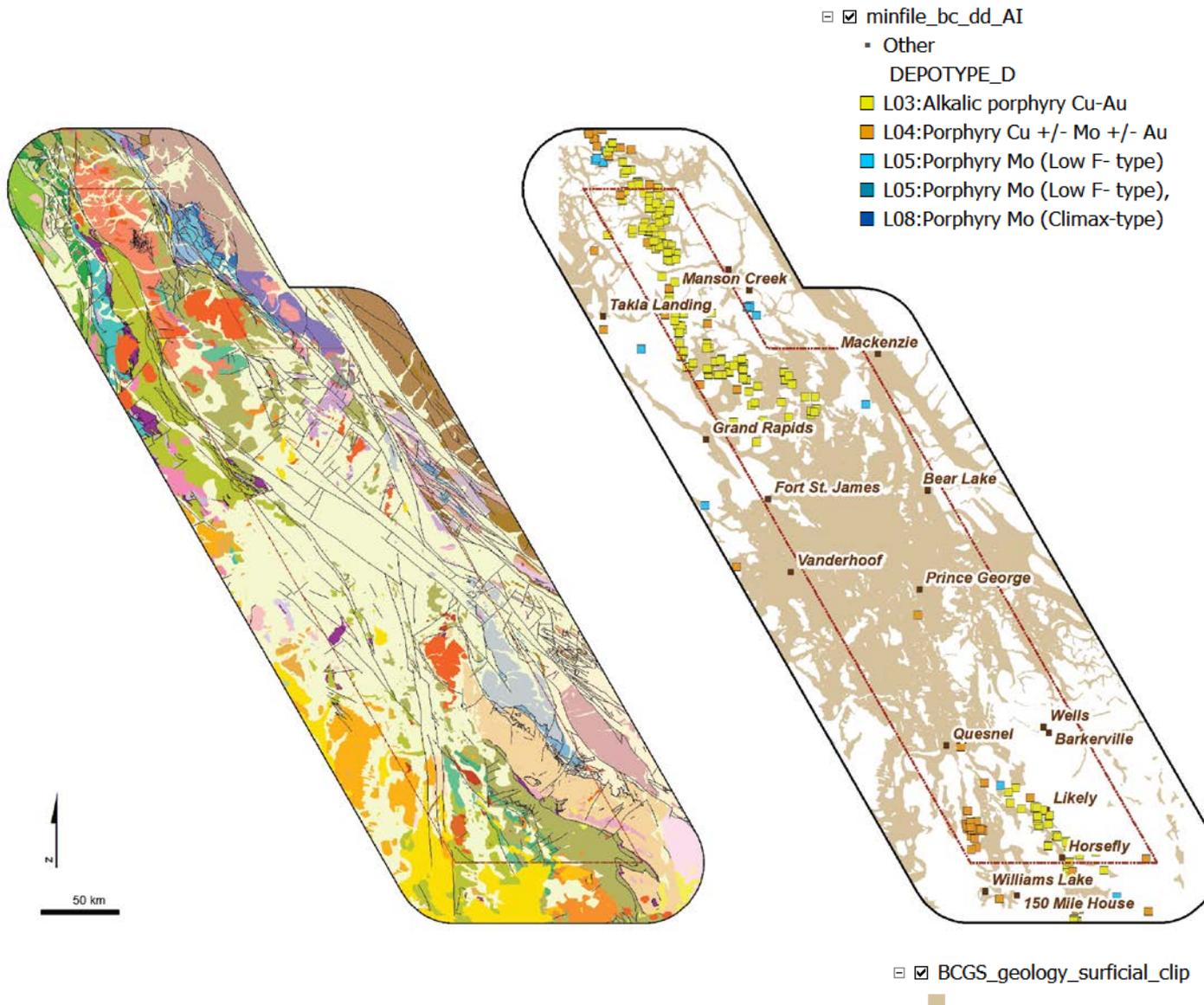


- Porphyry deposit
- Cu-Au
 - Cu-(Mo/Au)
- Other Au deposit
- ◇ Orogenic veins and placer

Upward Continued Residual Filters

- In order to represent depth surfaces, a series of upward-continued datasets were produced for both, magnetic and gravity datasets
- 500 m - 0 m (depth slice from surface to ~250 m): Includes the maximum thickness of Quaternary drift cover (~200 m; Andrews and Russell, 2010) and Miocene–Pleistocene Chilcotin Group basalts
- 1000 m to 500 m (depth slice from ~250 m to ~500 m): Suppress the magnetic signal of the Chilcotin Group and Quaternary drift
- 5000 m to 1000 m (equivalent to a ~500 m to ~2500 m depth slice): For shallow upper crust with Mesozoic plutons and Mesozoic and Paleozoic metamorphic assemblages that occur below unmetamorphosed volcanic and sedimentary rocks

BCGS Geological Map (Massey et al., 2005)



- The geological data utilized in this project includes the British Columbia Geology Survey (BCGS) Open File 2013-04 map (Cui et al. 2013). Its source data was originally released in 2005 (Massey et al., 2005)
- This study utilize mineral deposit and occurrences data from the BCGS MINFILE database (BC Geological Survey, 2014)
- Approximately half of the work area is covered by superficial sediments (BCGS Open File 2013-04 ; Cui et al. 2013)

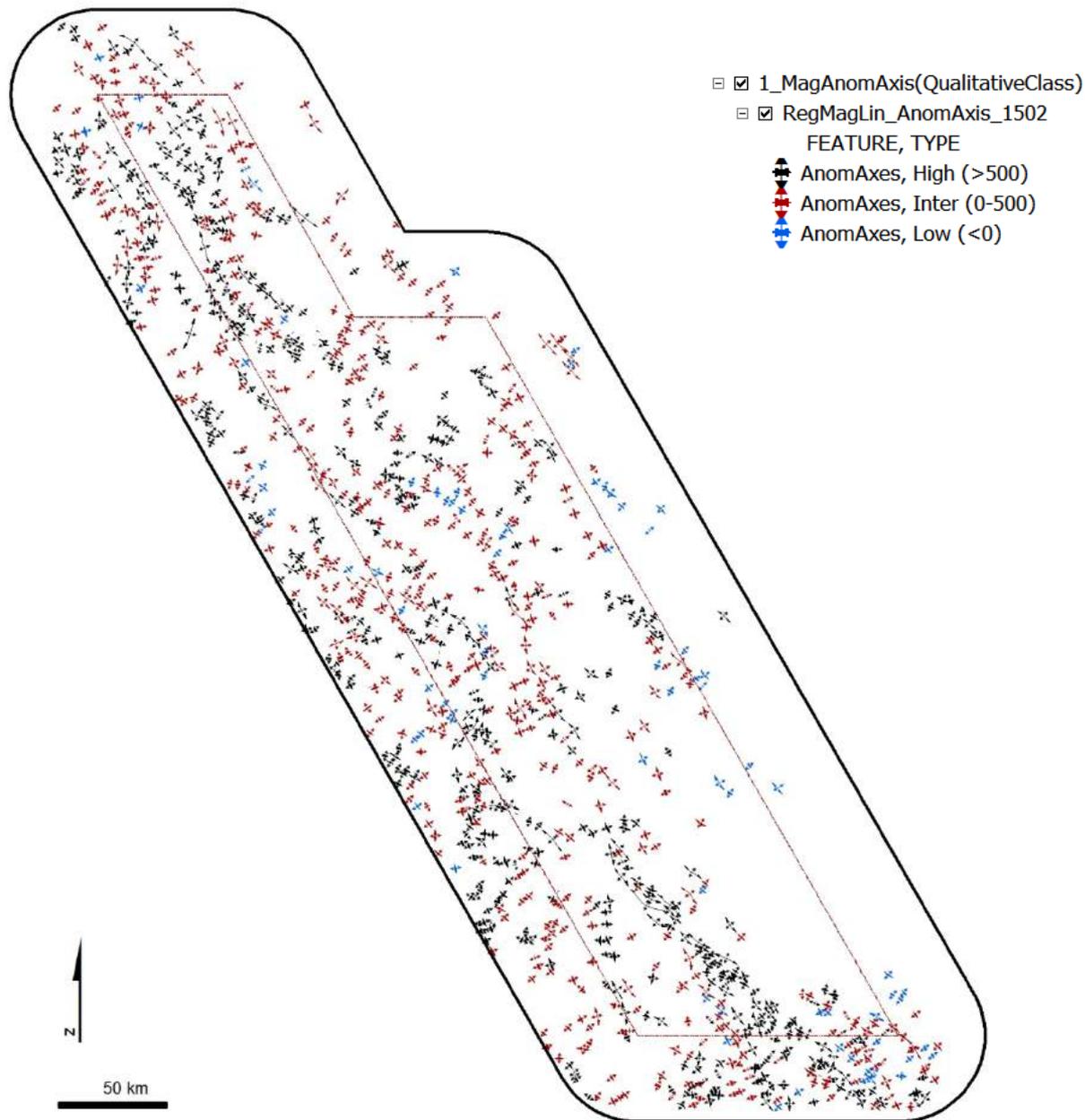
Interpretation and Analysis of Magnetic and Gravity Datasets, QUEST Area, Central British Columbia

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(NTS SHEETS 093A, B; 093F - K, 093M - O; 094C, D)

Anomaly axis of RTP aeromagnetic anomalies





Anomaly axis of RTP aeromagnetic anomalies

The long axis of elliptical-shaped high intensity RTP aeromagnetic anomalies were manually traced using:

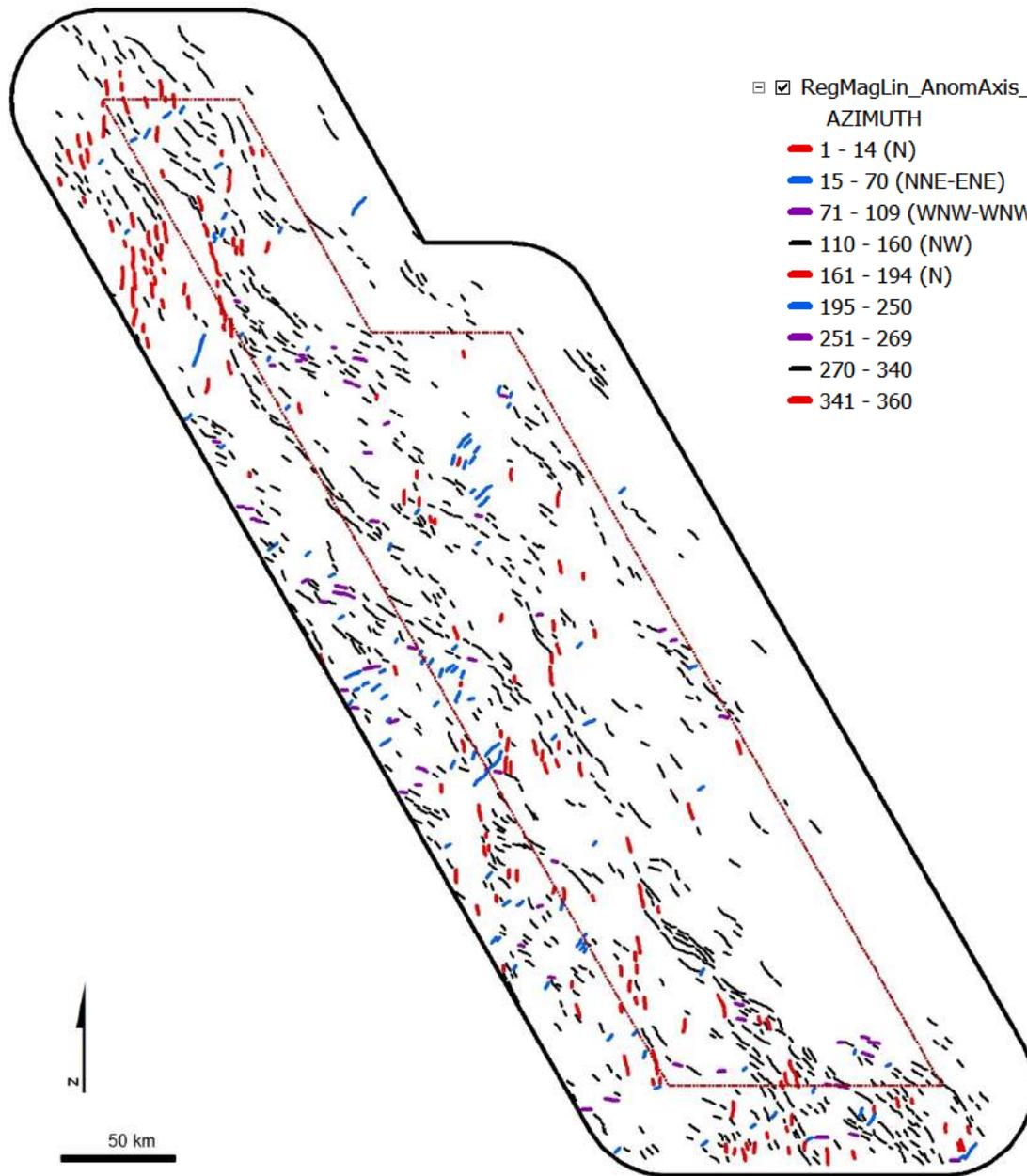
- High-pass filters
- Non-filtered grid

These were classified in three levels upon their RTP magnetic intensity:

- High (> 500 nT)
- Inter (0 - 500 nT)
- Low (<0 nT)

High intensity RTP aeromagnetic anomalies may represent:

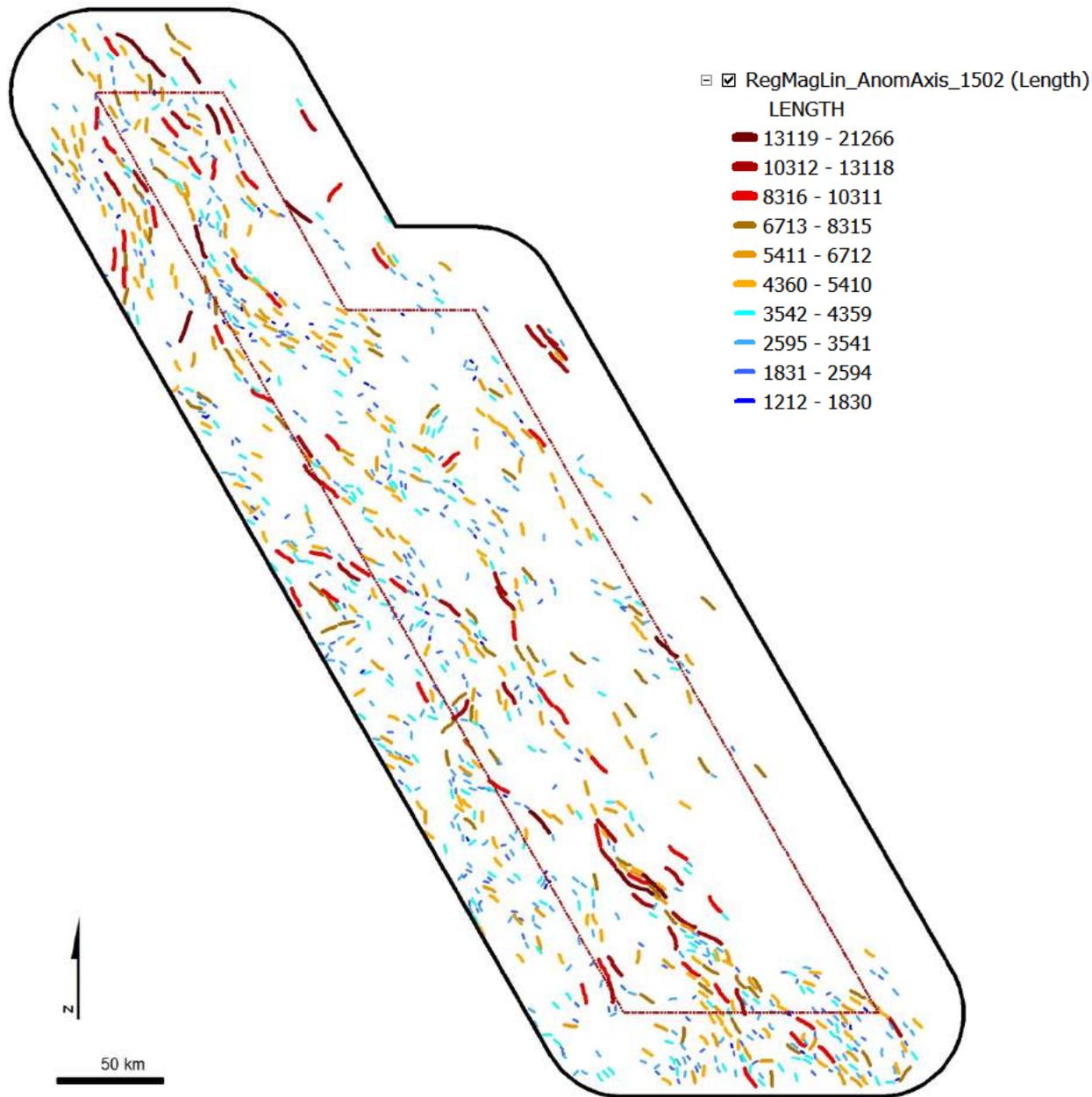
- Structural fabric
- Magnetic dykes
- Small intrusions
- Other higher magnetic susceptibility features



Anomaly axis of RTP aeromagnetic anomalies

Spatial Classification

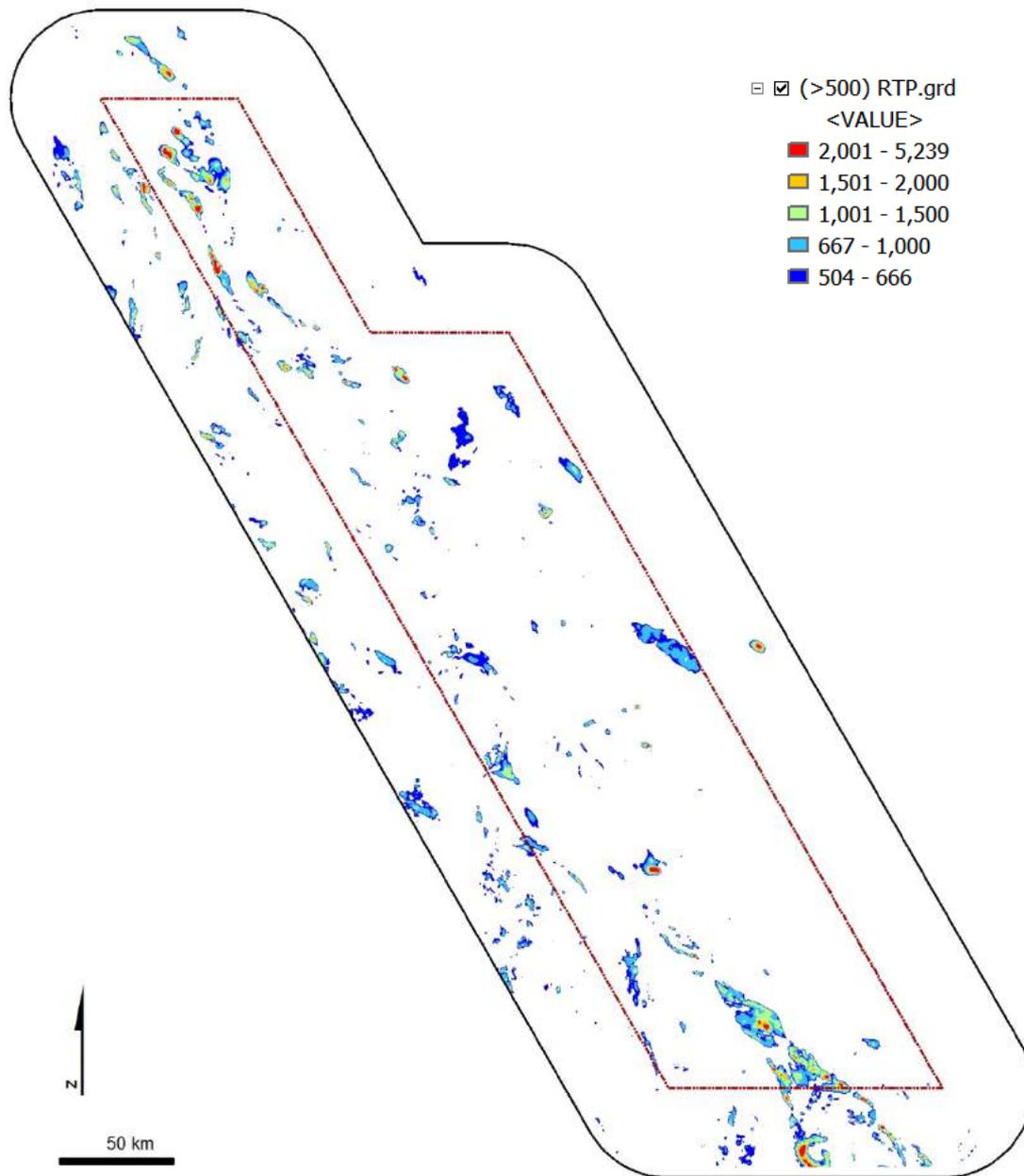
- Azimuth extraction and colour-classification



Anomaly axis of RTP aeromagnetic anomalies

Spatial Classification

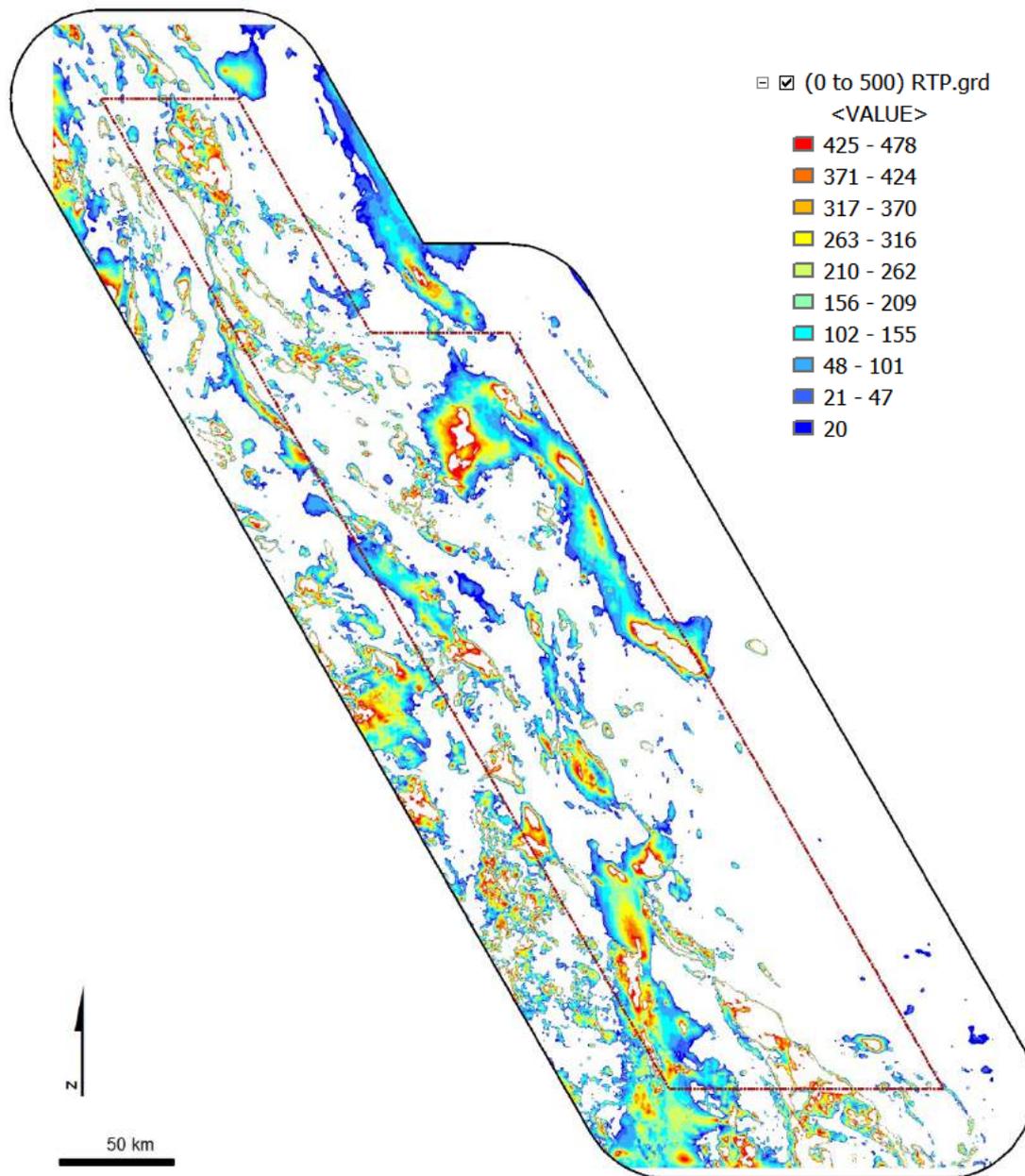
- Length (m) and colour-classification



Anomaly axis of RTP aeromagnetic anomalies

Grids used for intensity classification

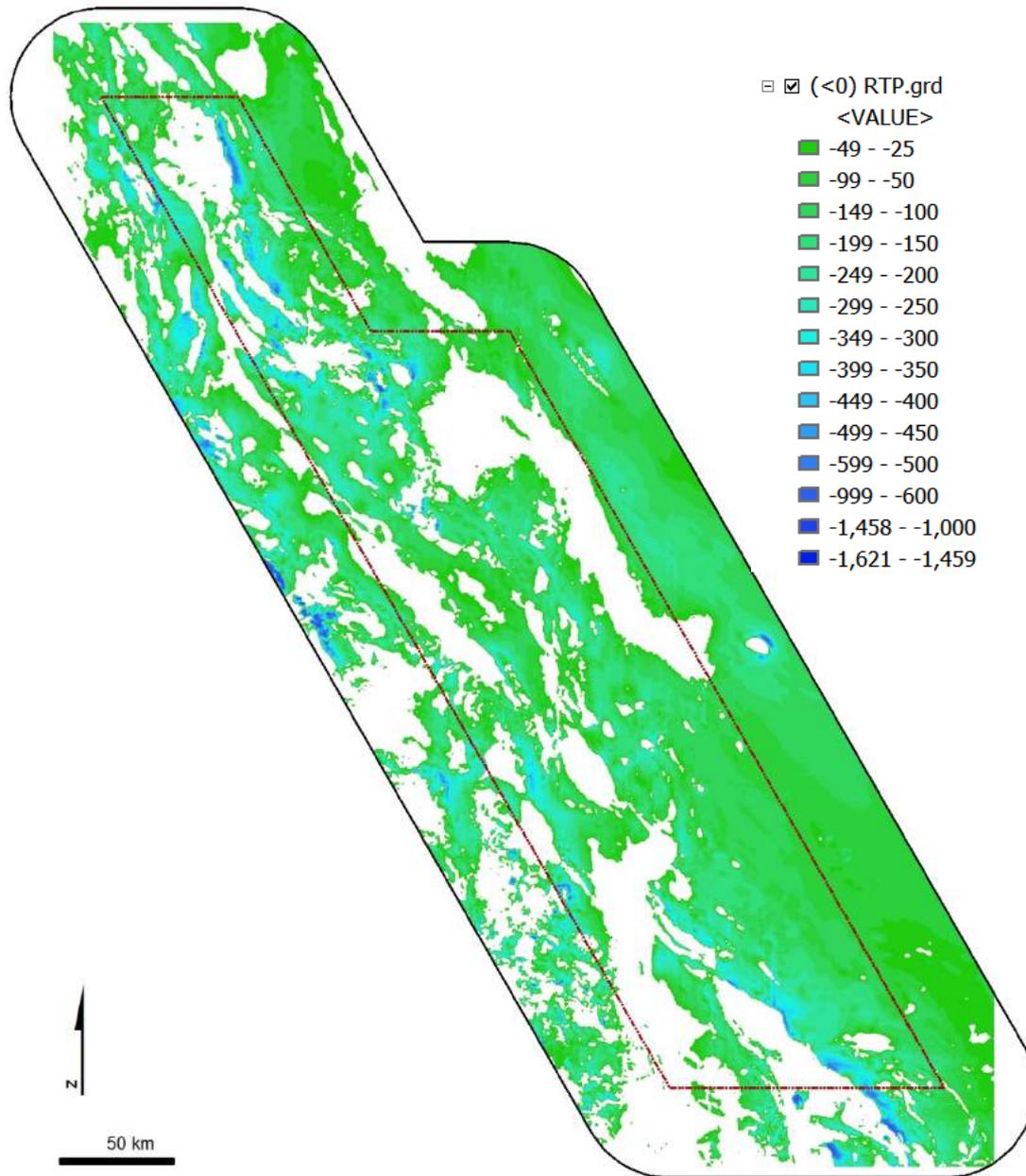
- RTP Magnetic grid ranges greater than 500 nT



Anomaly axis of RTP
aeromagnetic
anomalies

Grids used for intensity
classification

- RTP Magnetic grid ranges
between 0 and 500 nT



Anomaly axis of RTP aeromagnetic anomalies

Grids used for intensity classification

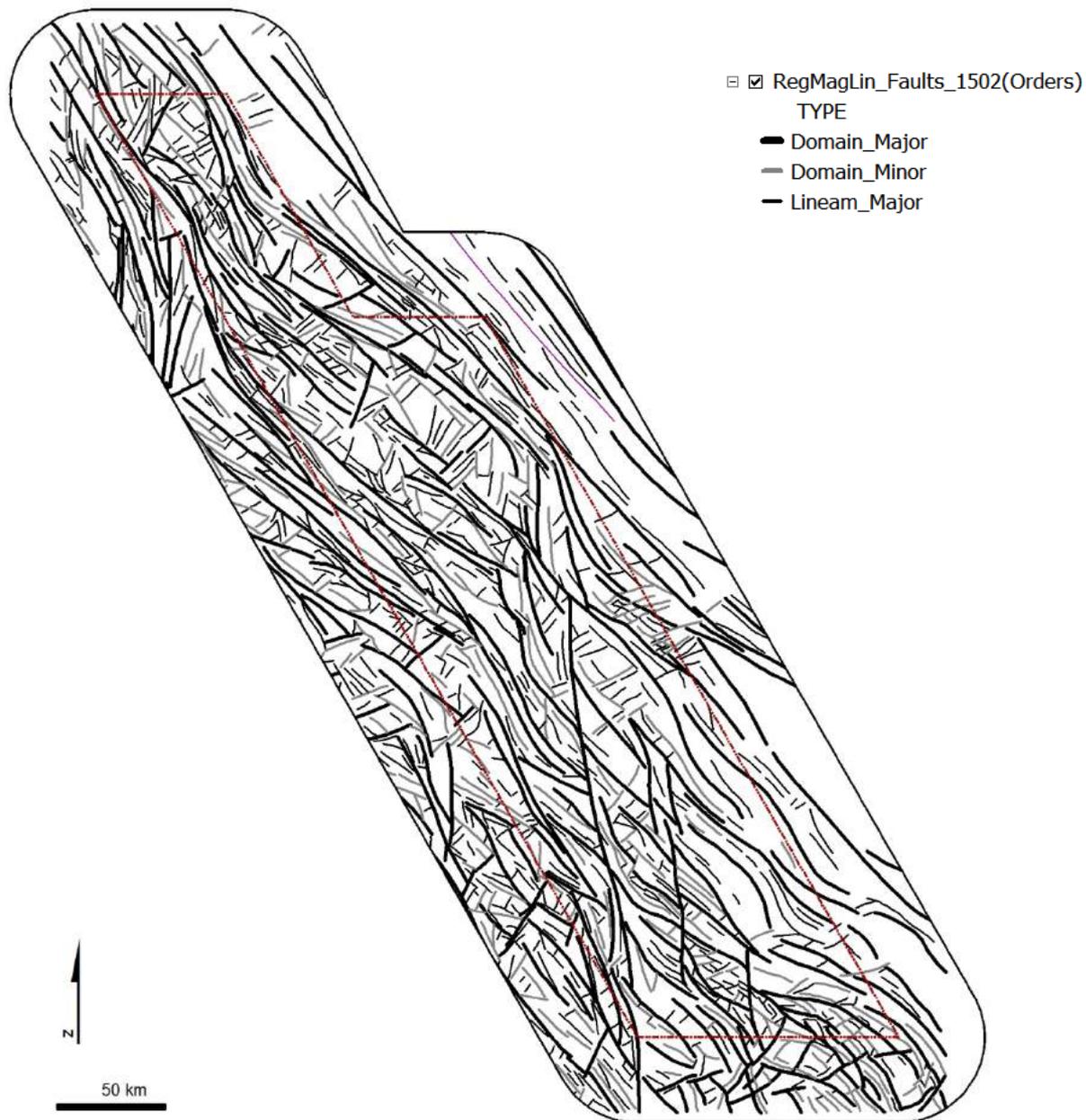
- RTP Magnetic grid ranges below 500 nT

Interpretation and Analysis of Magnetic and Gravity Datasets, QUEST Area, Central British Columbia

(NTS SHEETS 093A, B; 093F - K, 093M - O; 094C, D)

Aeromagnetic lineaments





Aeromagnetic lineaments

We focus on high-frequency and variable-intensity aeromagnetic lineaments that correspond to discontinuities with an aeromagnetic domain change

A systematic, multi-dataset methodology was used to compare lineaments against various data layer

Classification:

- Domain_Major (lineaments bounding major magnetic domain)
- Domain_Minor (bounding minor magnetic domain)
- Lineam_Major (within a magnetic domain)

Potential-field data filters used for interpretation:

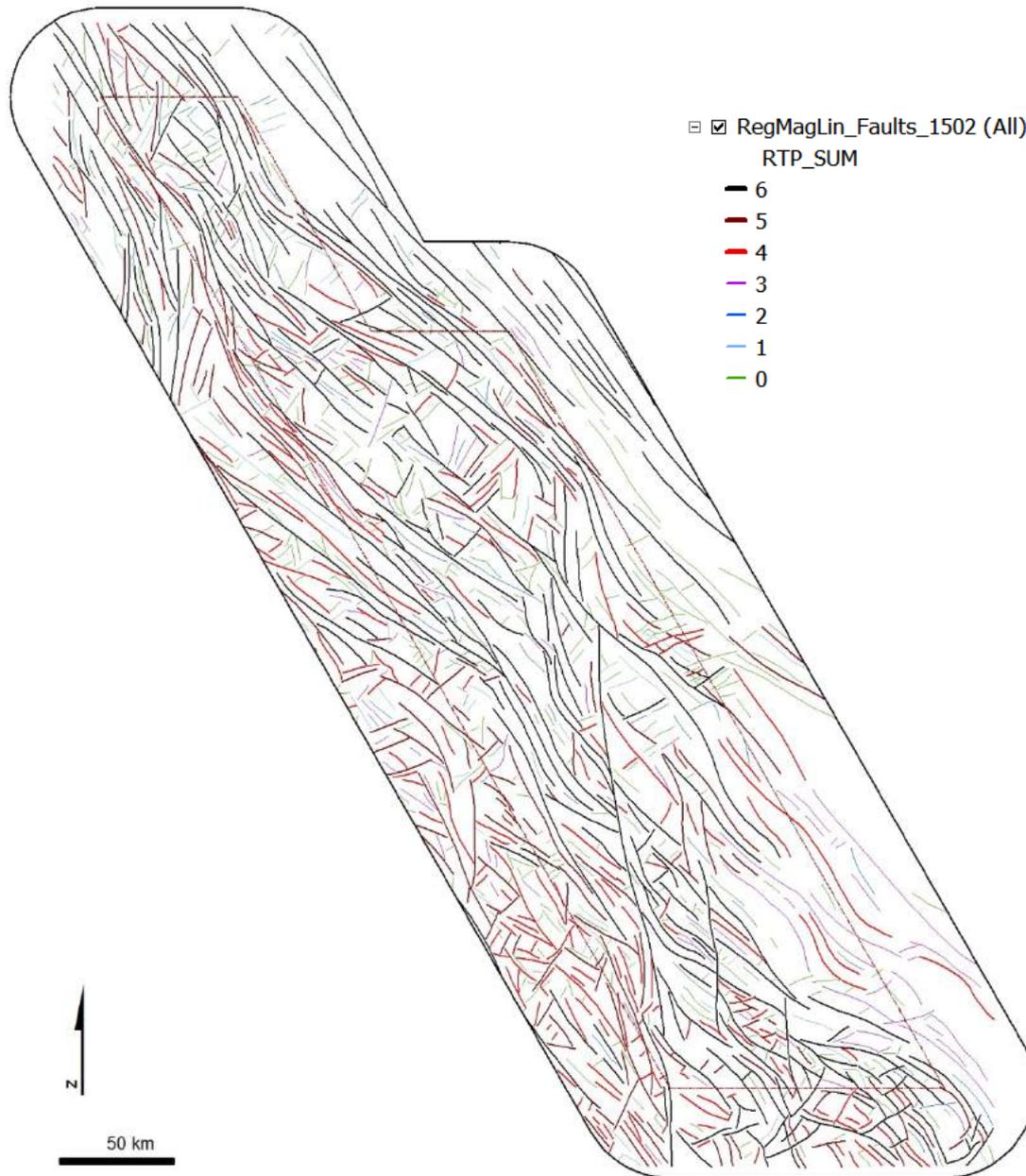
- RD (UpCon Residual Deep)
- RI (UpCon Residual Intermediate)
- RI_HP (UpCon Residual Intermediate with High Pass filtering)



Aeromagnetic lineaments

Reliability Index

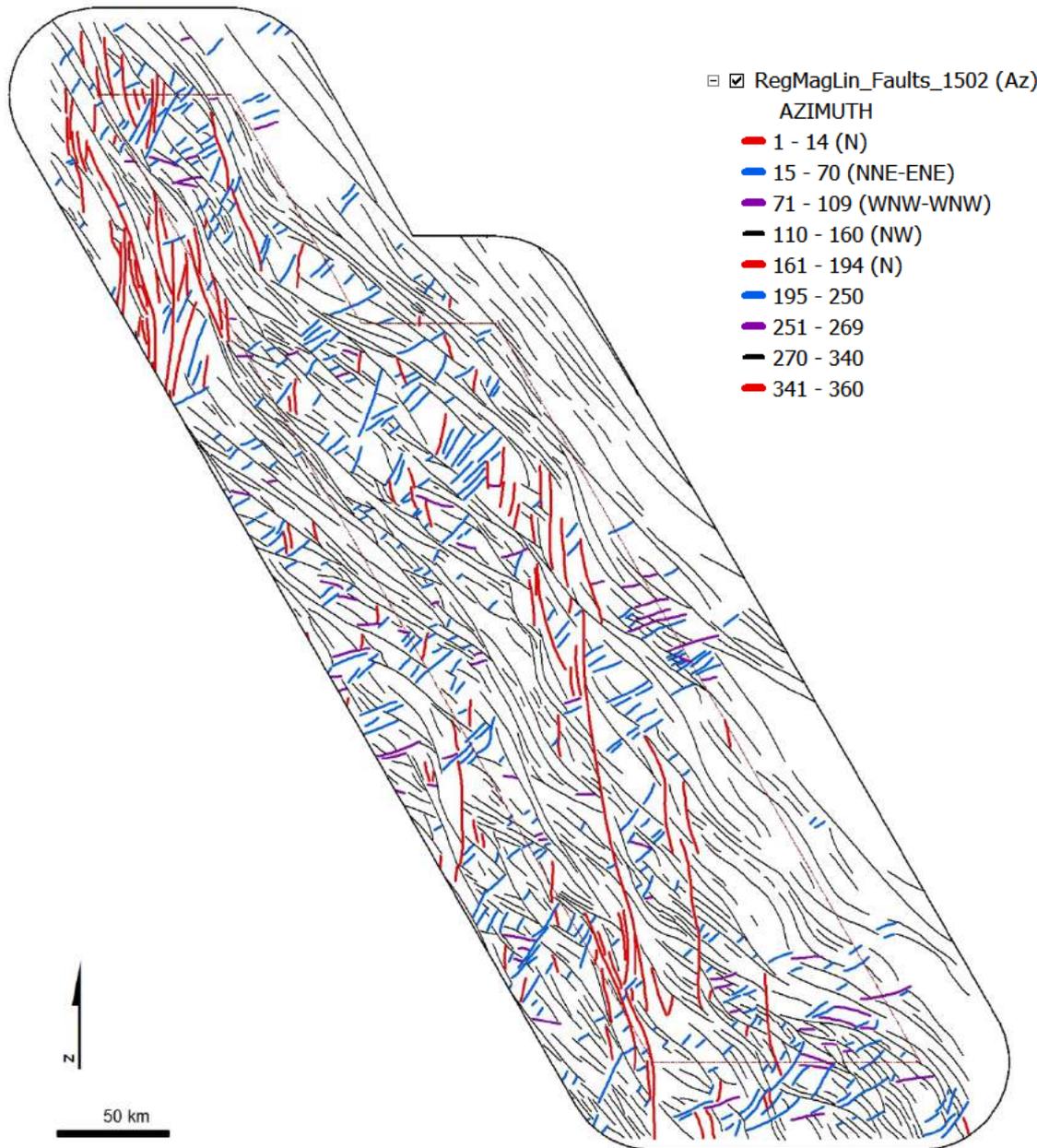
- 1 or 0 if lineament is, respectively, observed or not observed in RTP magnetic data
- Top two ranked lineaments



Aeromagnetic lineaments

Reliability Index

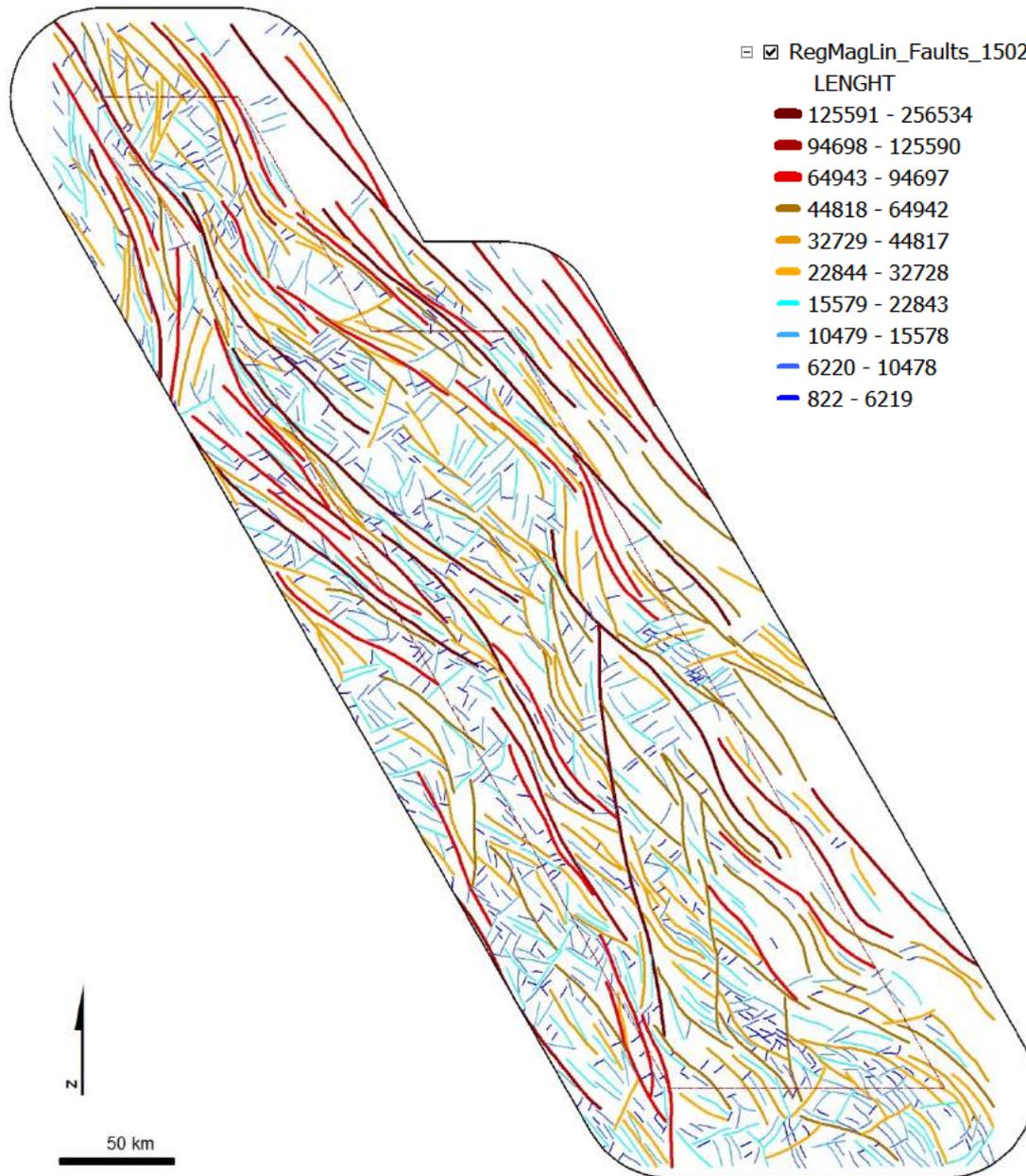
- 1 or 0 if lineament is, respectively, observed or not observed in RTP magnetic data
- All ranked lineaments



Aeromagnetic lineaments

Spatial Classification

- Azimuth calculation and colour-classification

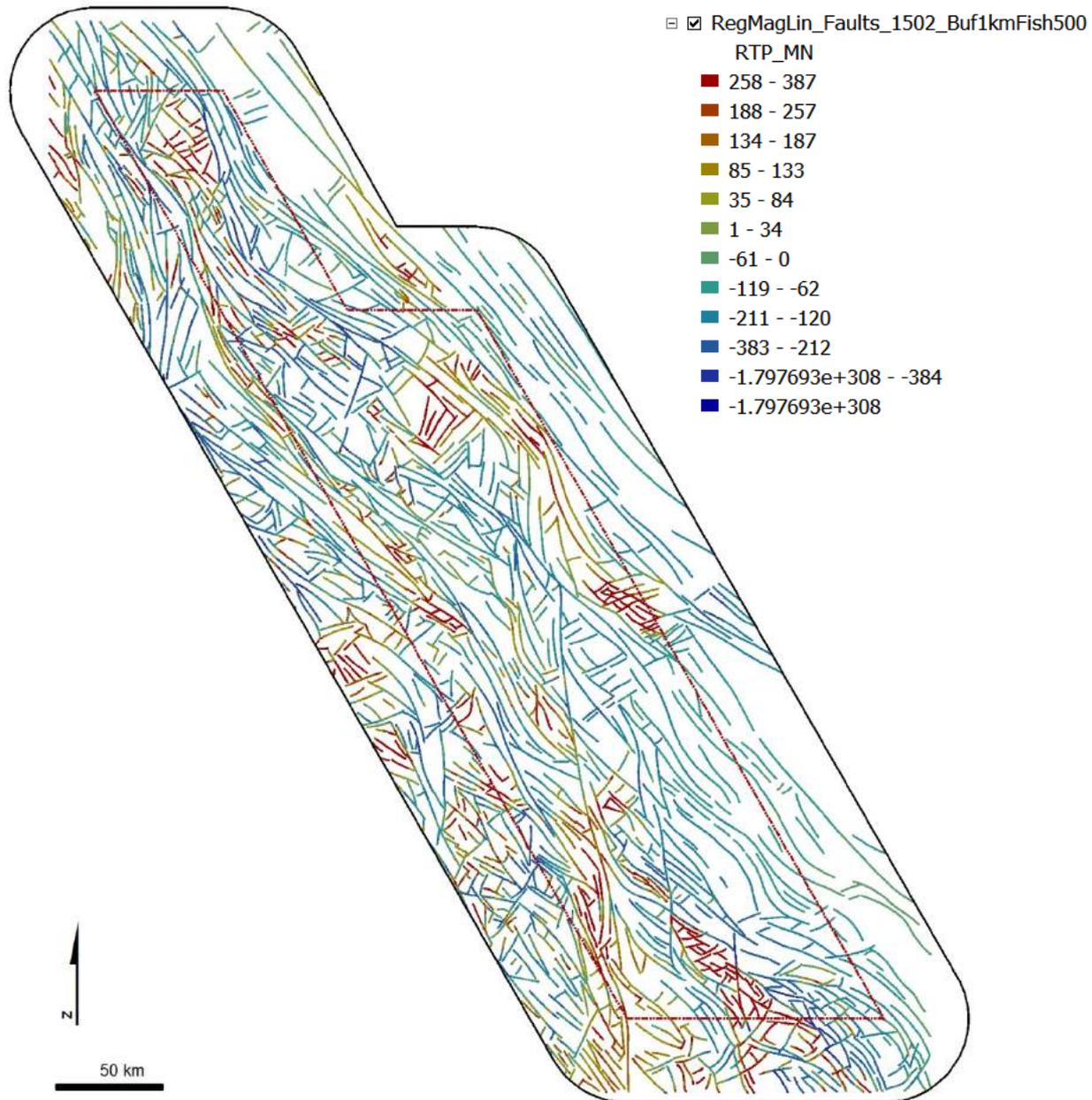


Aeromagnetic lineaments

Spatial Classification

- Length calculation and colour-classification

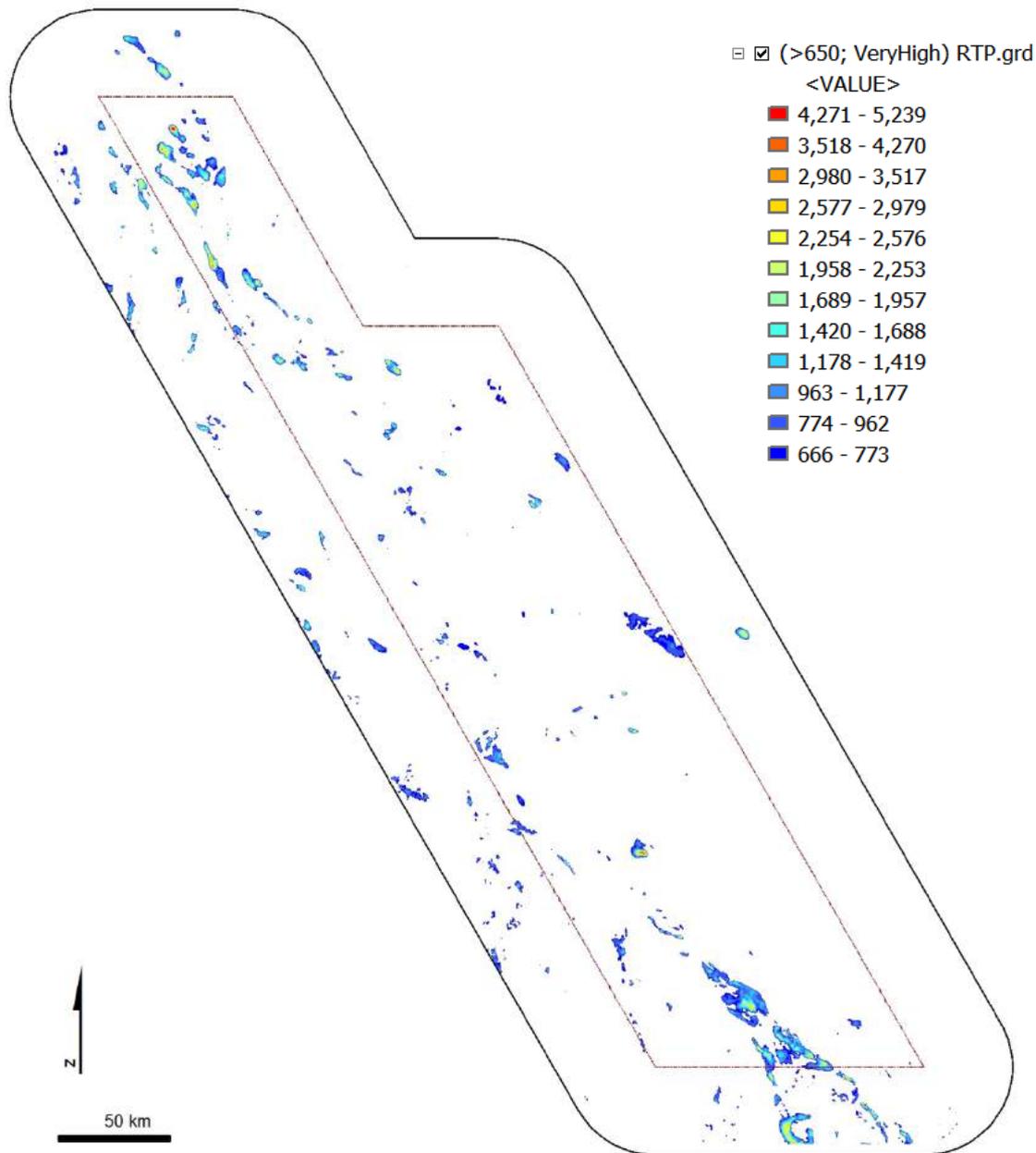




Aeromagnetic lineaments

Quantitative Classification

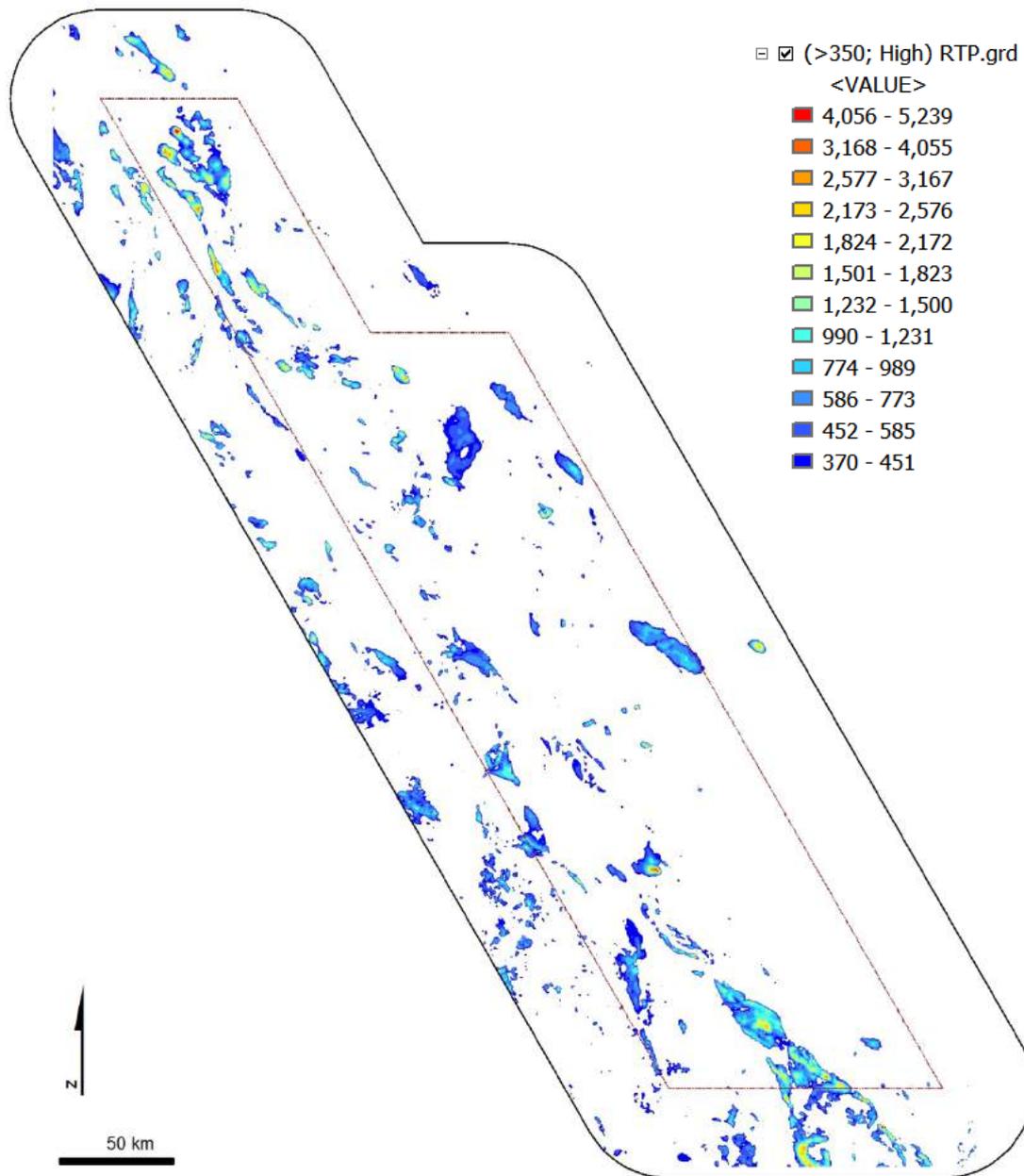
- Lineament statistics (mean value) calculated from RTP aeromagnetic grid within 1 km buffer zone (fault zone)



Aeromagnetic lineaments

Grids used for intensity classification

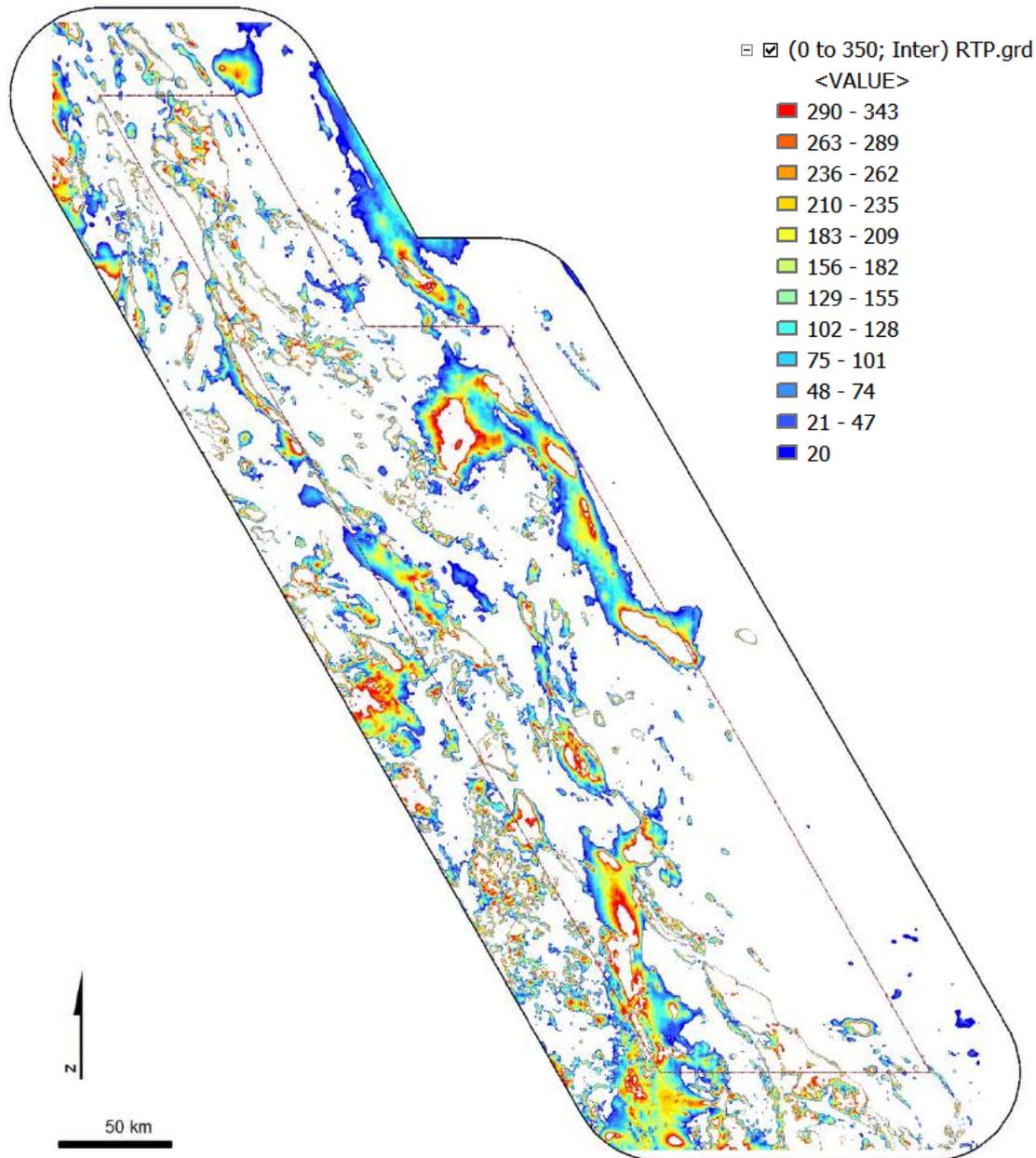
- RTP Magnetic grid range greater than 650 nT
- Used for very high intensity classification



Aeromagnetic lineaments

Grids used for intensity classification

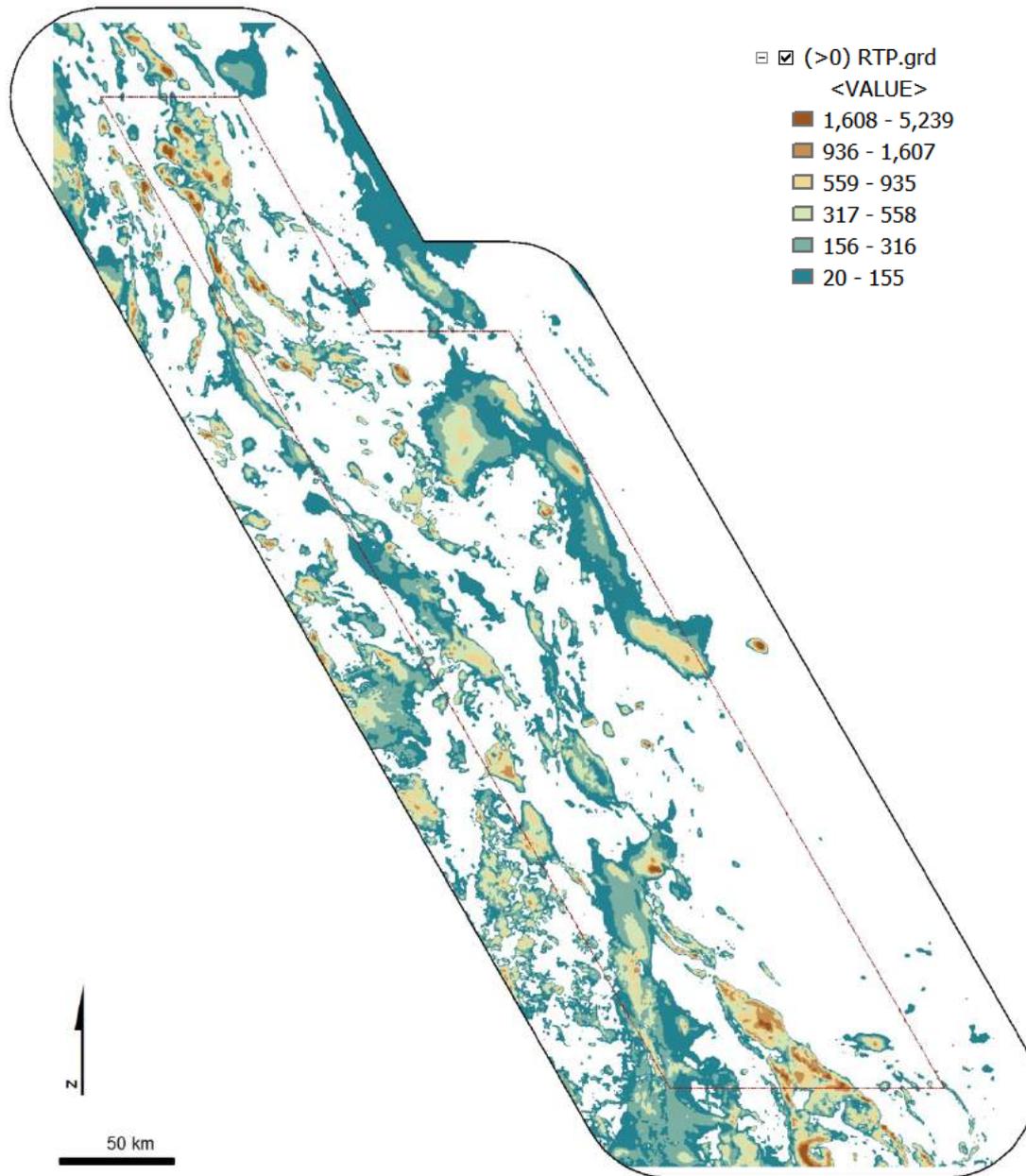
- RTP Magnetic grid range greater than 350 nT
- Used for high intensity classification



Aeromagnetic lineaments

Grids used for intensity classification

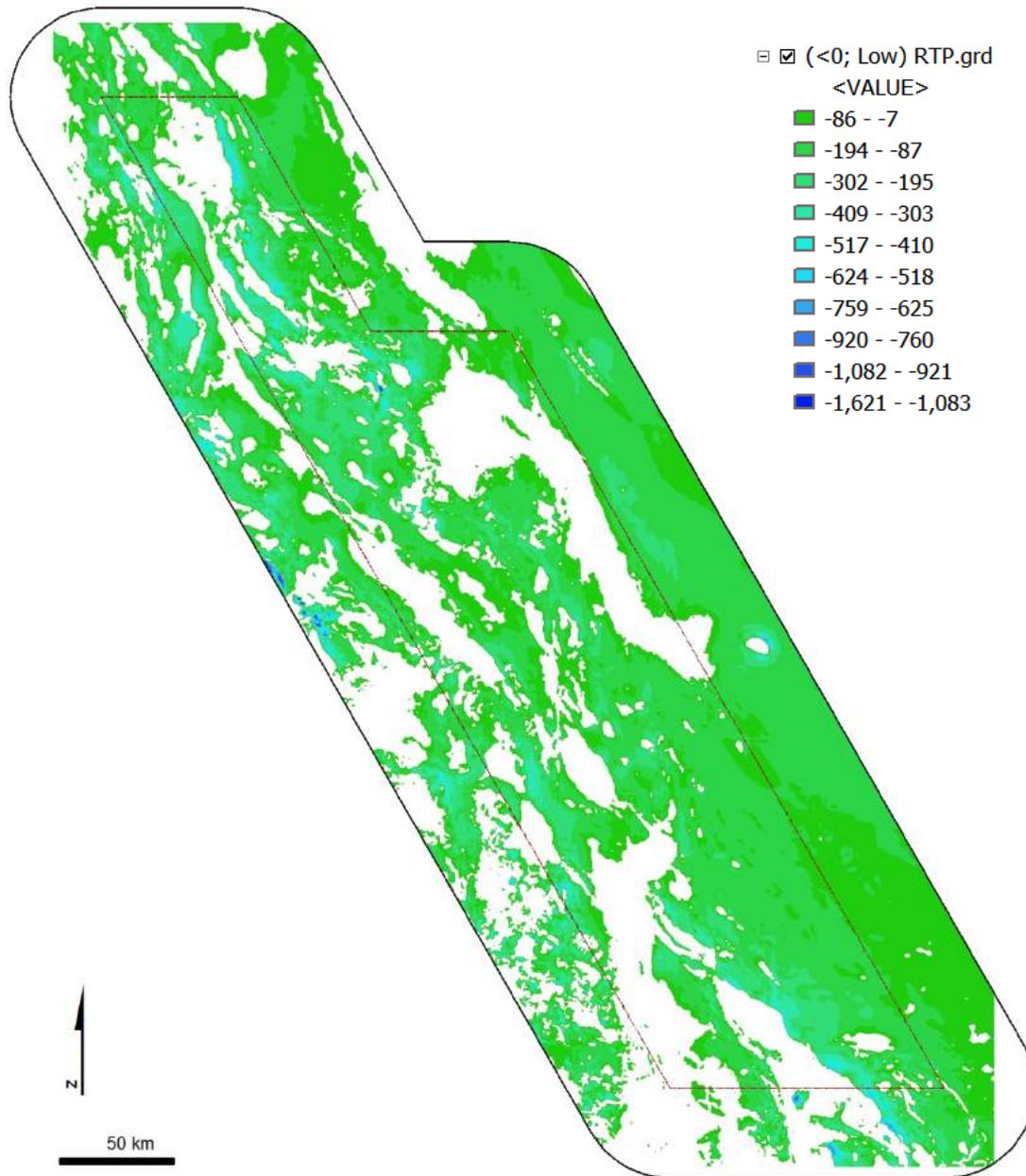
- RTP Magnetic grid range between 0 nT and 350 nT
- Used for intermediate intensity classification



Aeromagnetic lineaments

Grids used for intensity classification

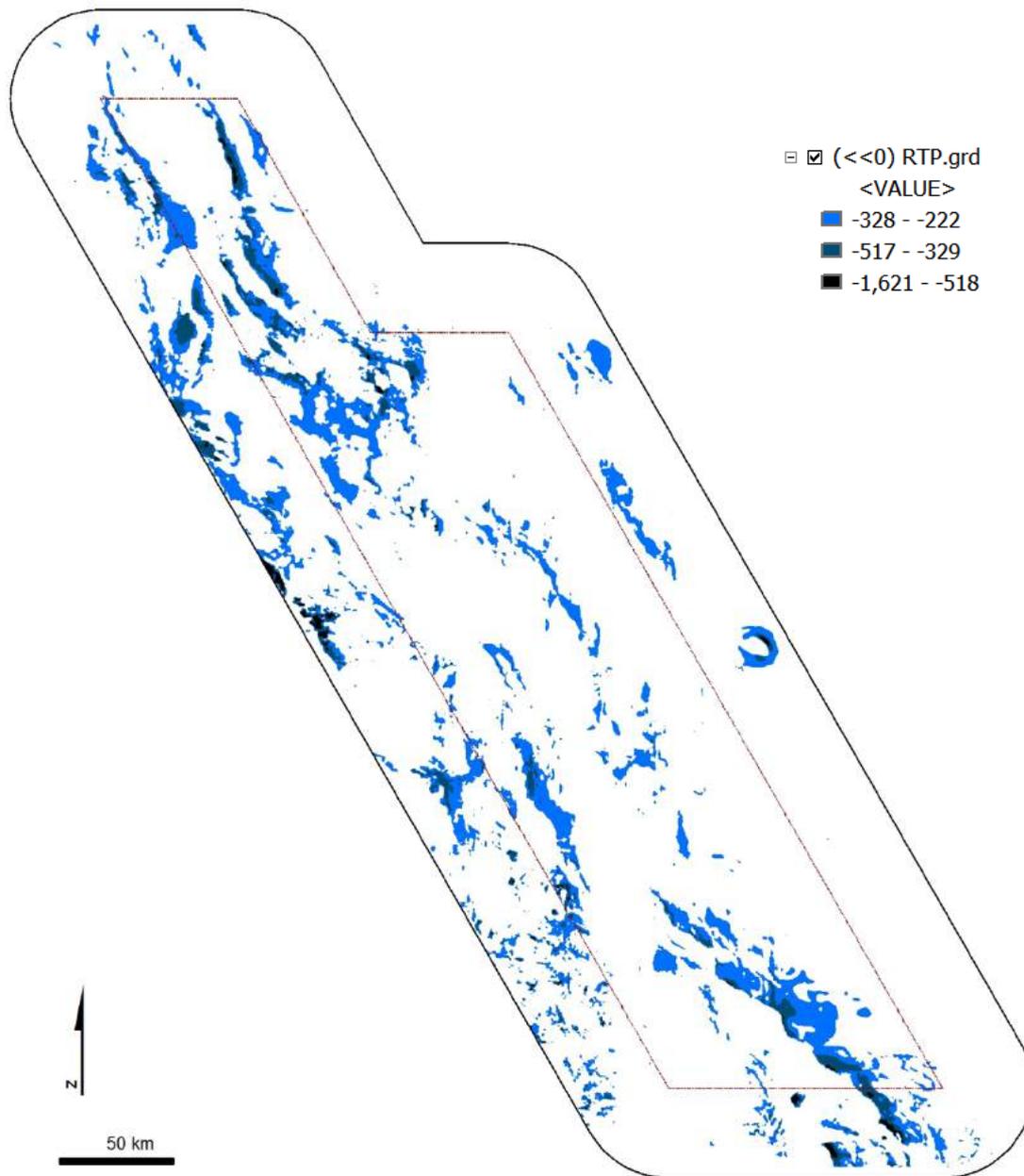
- RTP Magnetic positive grid values
- Used for intensity classification



Aeromagnetic lineaments

Grids used for intensity classification

- RTP Magnetic negative grid values
- Used for intensity classification



Aeromagnetic lineaments

Grids used for intensity classification

- RTP Magnetic very low negative grid values
- Used for intensity classification

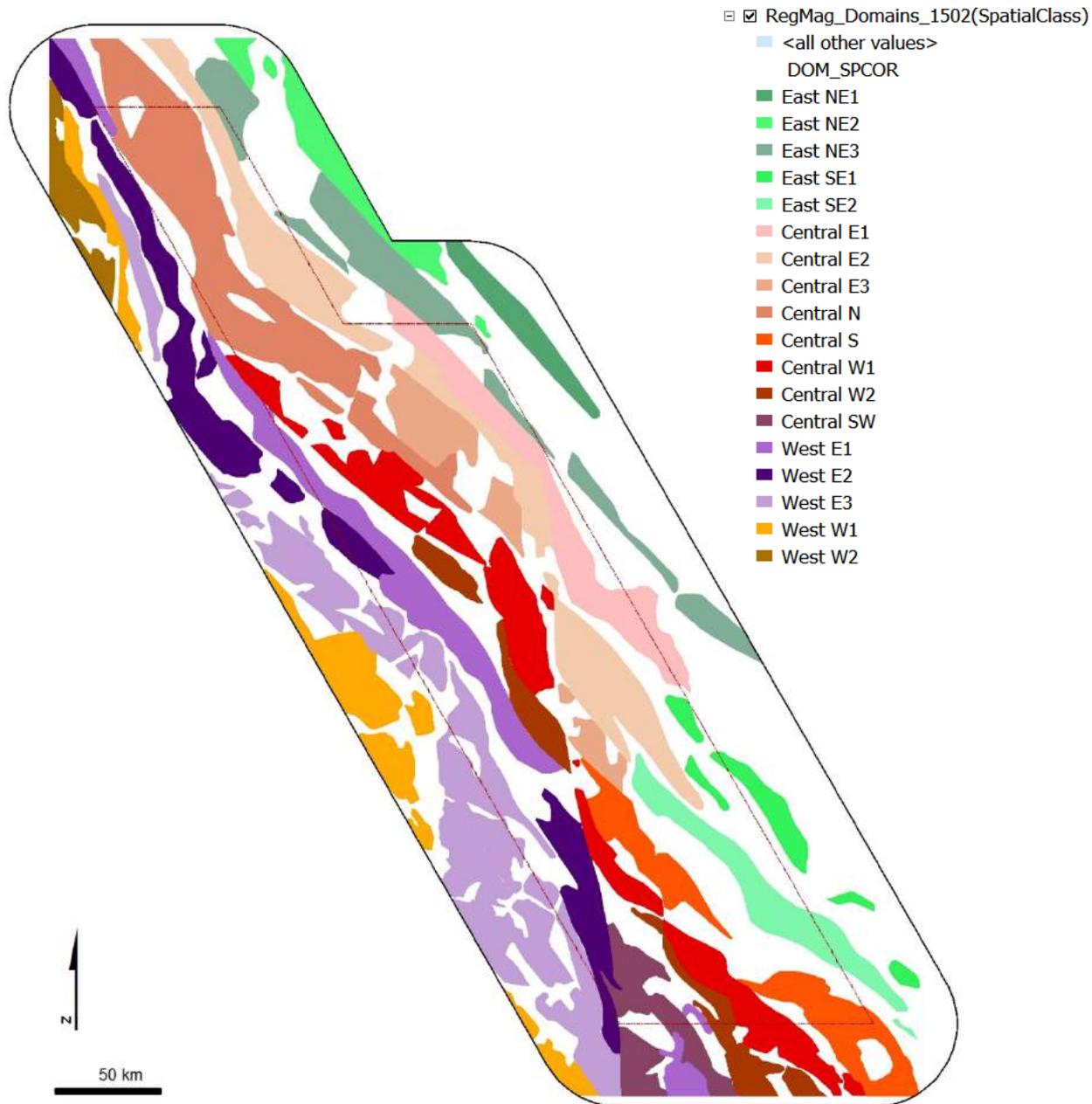
Interpretation and Analysis of Magnetic and Gravity Datasets, QUEST Area, Central British Columbia

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(NTS SHEETS 093A, B; 093F - K, 093M - O; 094C, D)

Major aeromagnetic domains



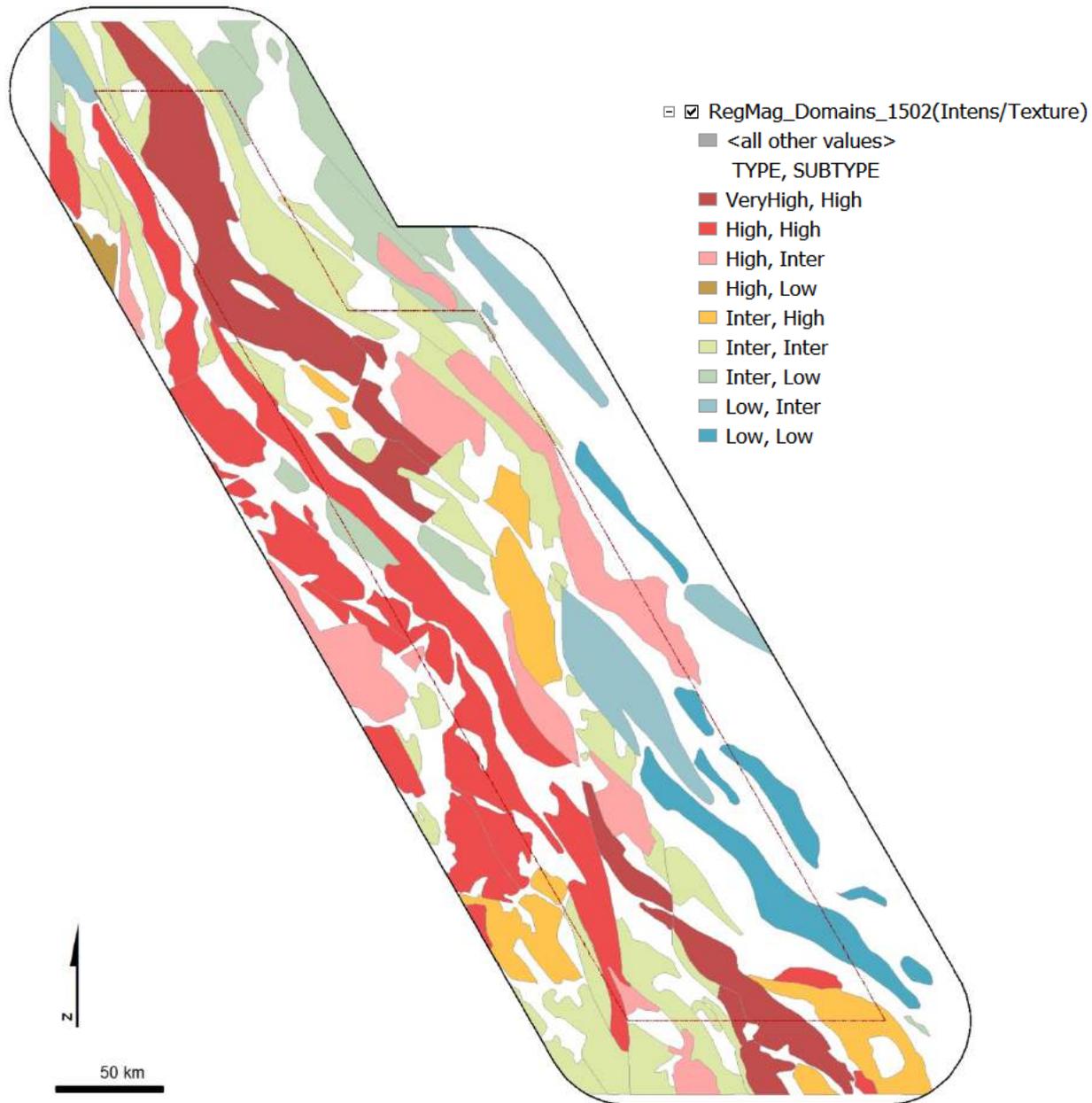


Major aeromagnetic domains

- Magnetic domains are spatially-related areas of similar magnetic intensity and frequency (texture)
- Polygons were manually traced using high-pass and low-pass filters for qualitative characterization of “texture” and intensity
- Systematic sampling of gravity and magnetic grids for statistical analysis was used for quantitative characterization

The integrated interpretation of geophysical and geological datasets suggest three NNW-oriented groups of magnetic domains:

- Eastern
- Central
- Western

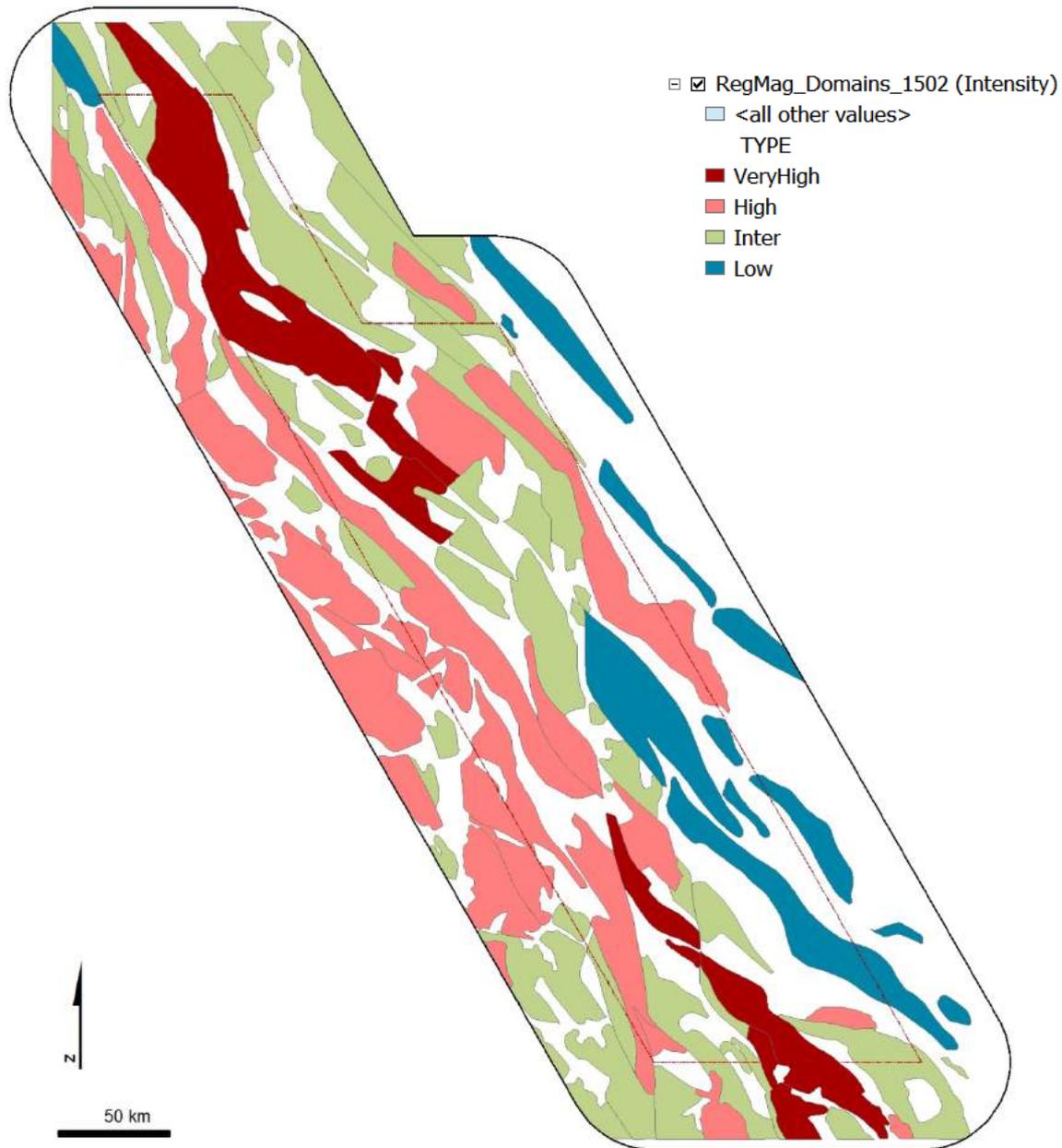


Major aeromagnetic domains

Qualitative Classification

Magnetic domains intensity and "texture" classification

Intensity (Type) Vs "texture" (Subtype)

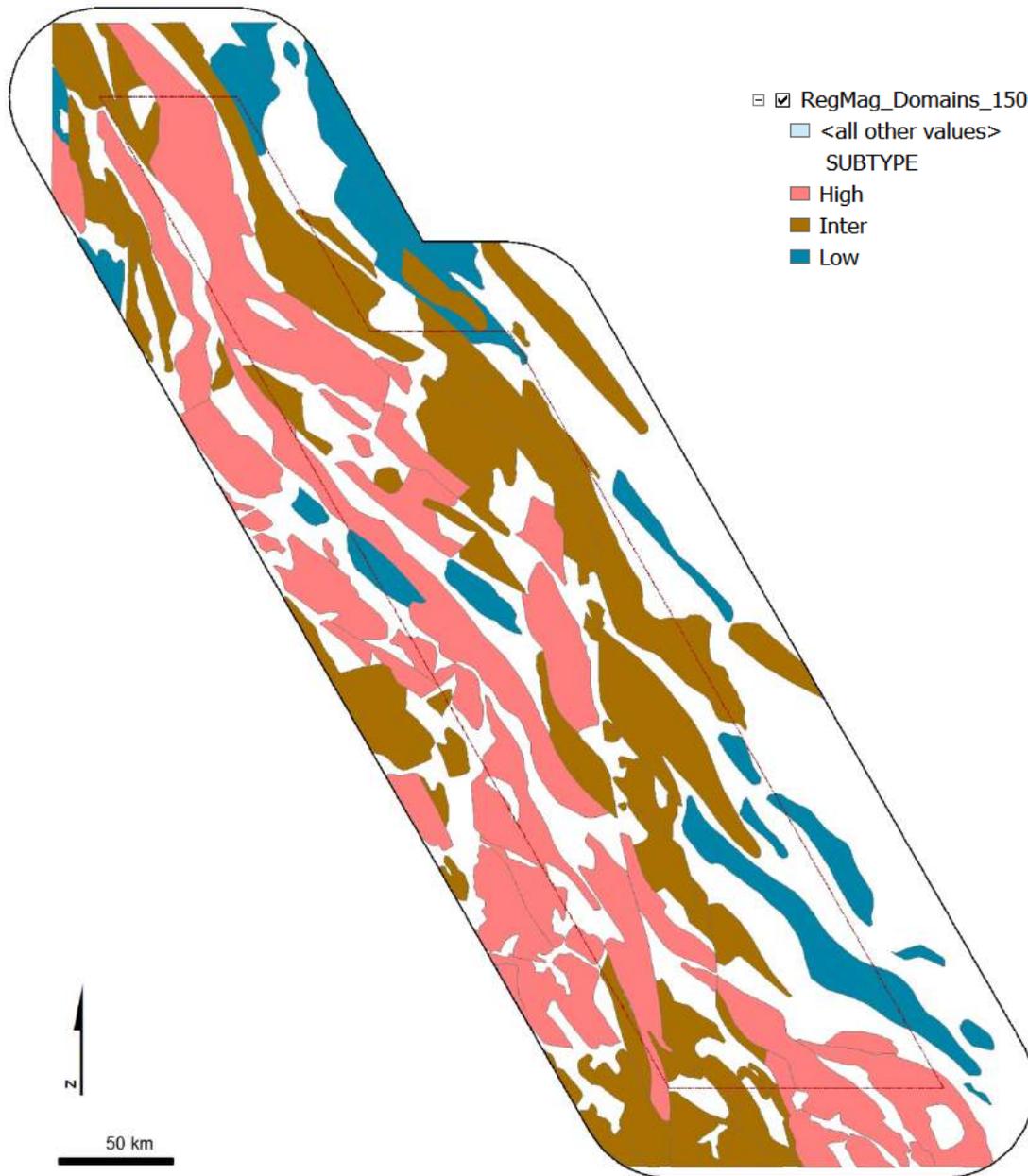


Major aeromagnetic domains

Qualitative Classification

Magnetic domains intensity classification

- RTP Aeromagnetic grid

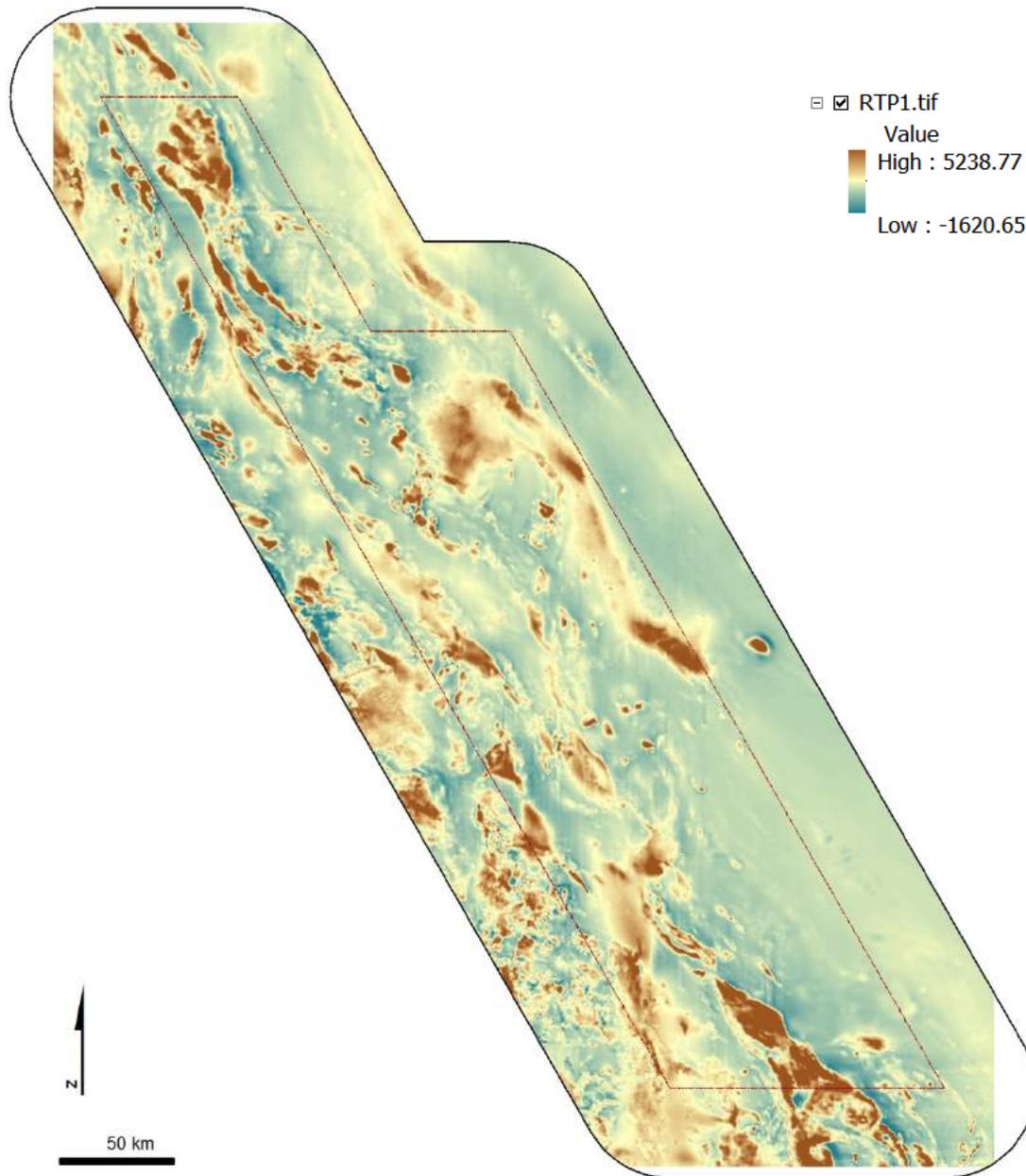


Major aeromagnetic domains statistics

Qualitative Classification

Magnetic domains frequency ("texture") classification

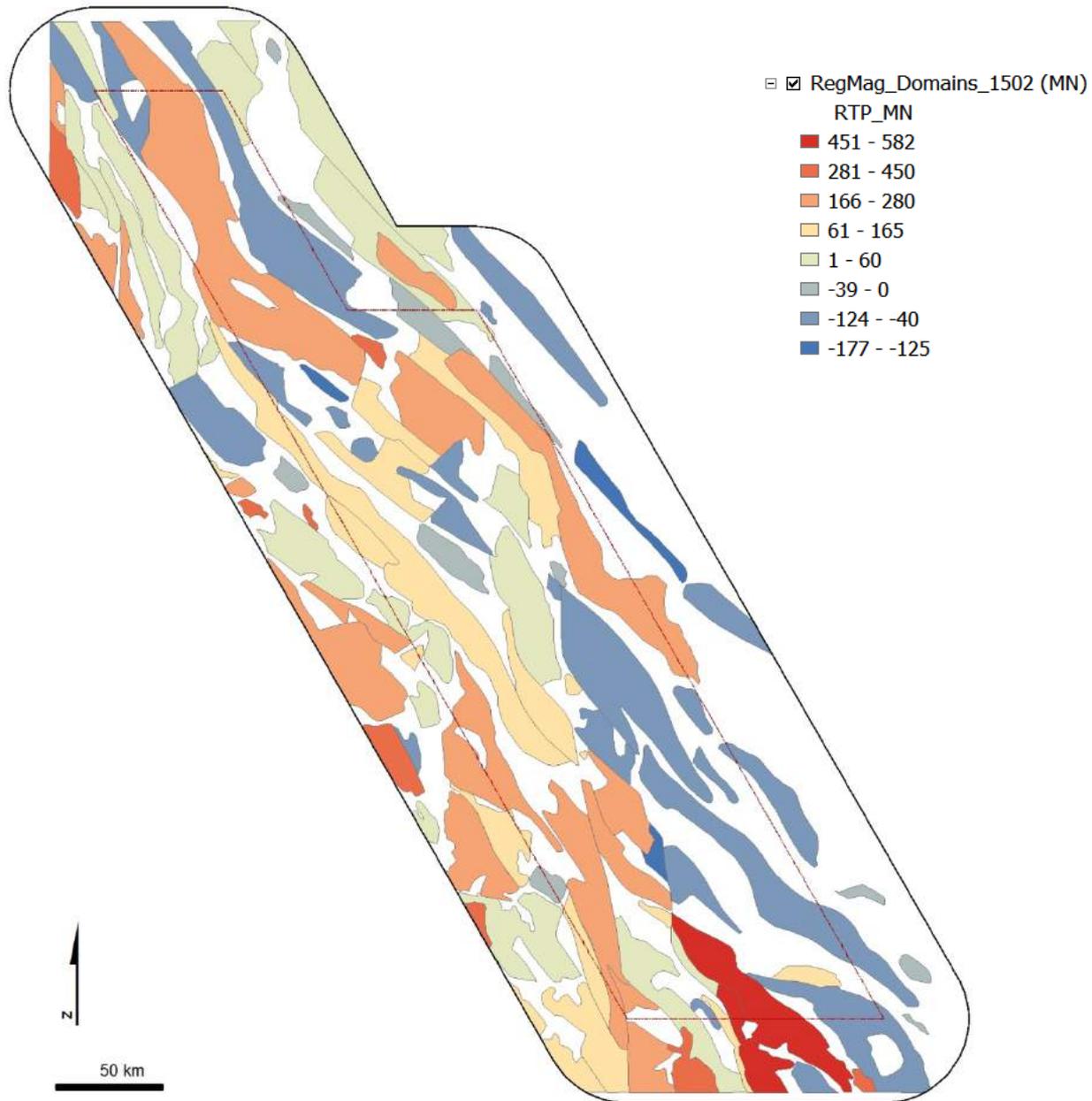
- Horizontal Gradient Magnitude (HGM) aeromagnetic grid



Major aeromagnetic domains statistics

Quantitative classification

RTP aeromagnetic grid used for intensity classification



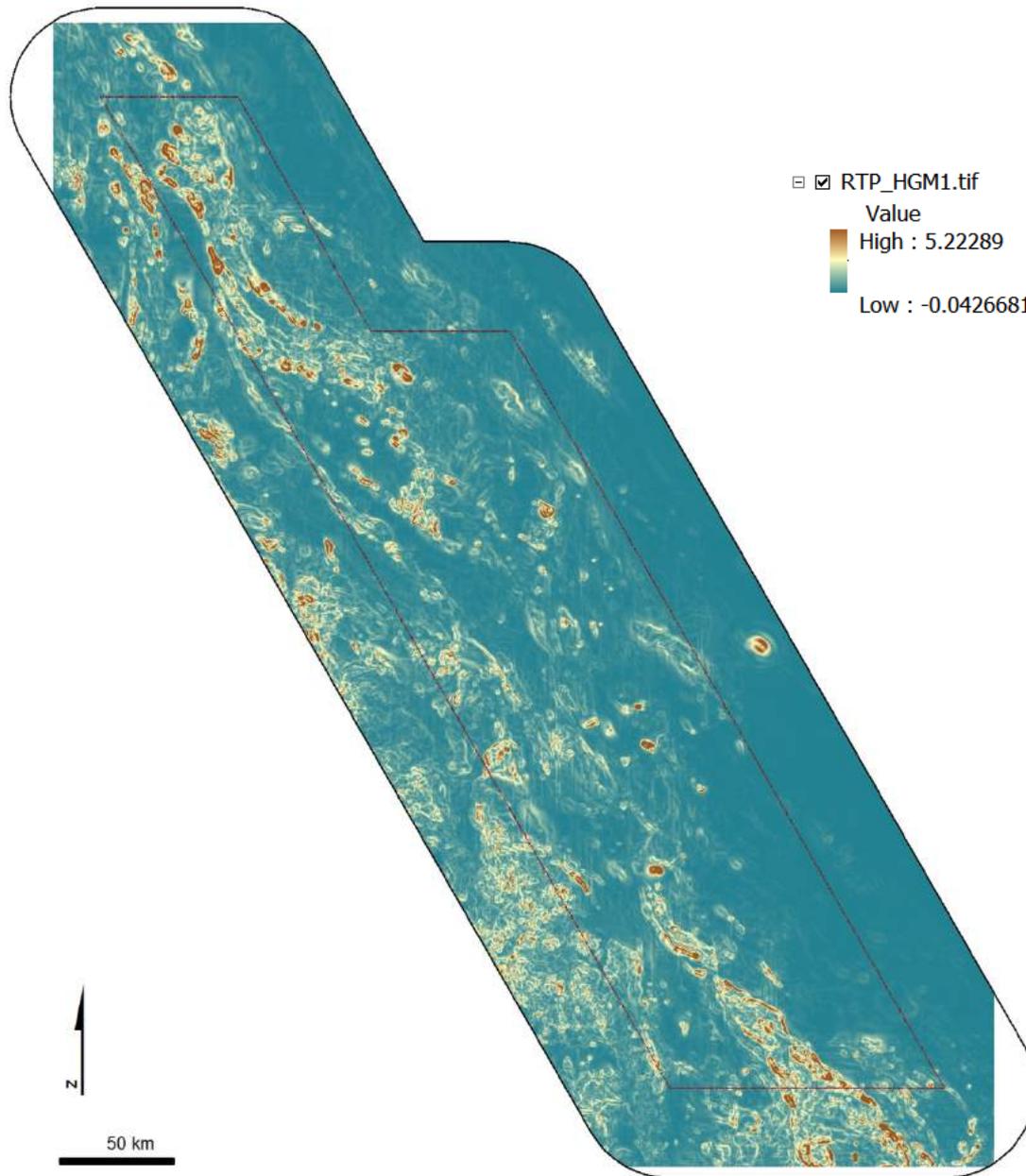
Major aeromagnetic domains statistics

Quantitative classification

Magnetic domains intensity classification

Mean (Mn) for grid cell values contained by polygons:

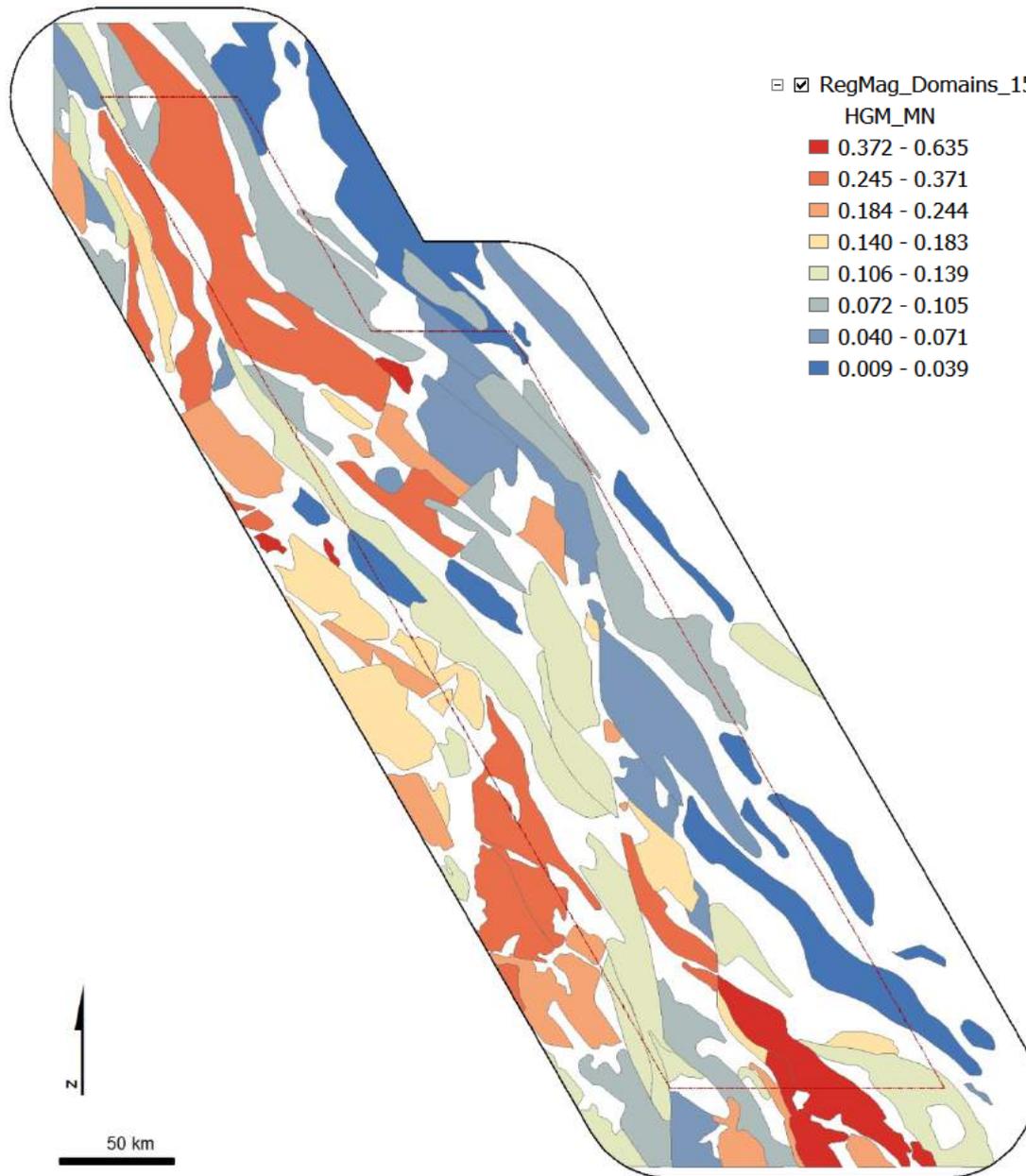
- RTP Aeromagnetic grid



Major aeromagnetic domains statistics

Quantitative classification

Horizontal Gradient Magnitude (HGM) of RTP aeromagnetic grid used for frequency (“texture”) classification



☐ RegMag_Domains_1502 (MN)

HGM_MN

- 0.372 - 0.635
- 0.245 - 0.371
- 0.184 - 0.244
- 0.140 - 0.183
- 0.106 - 0.139
- 0.072 - 0.105
- 0.040 - 0.071
- 0.009 - 0.039

Major aeromagnetic domains statistics

Quantitative Classification

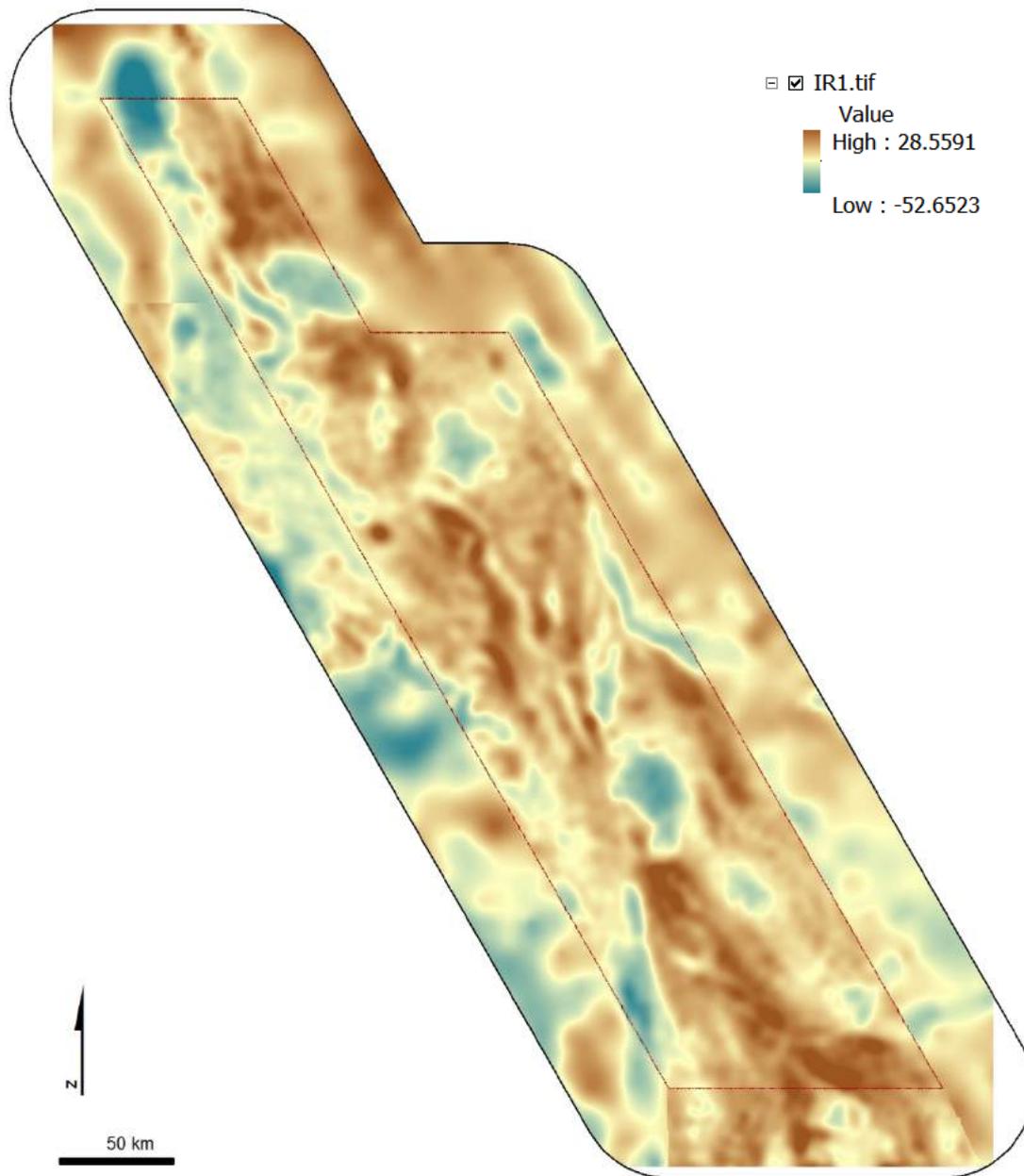
Magnetic domains (“texture”) classification

Mean for grid cell values contained by polygons:

- Horizontal Gradient Magnitude (HGM) Aeromagnetic grid



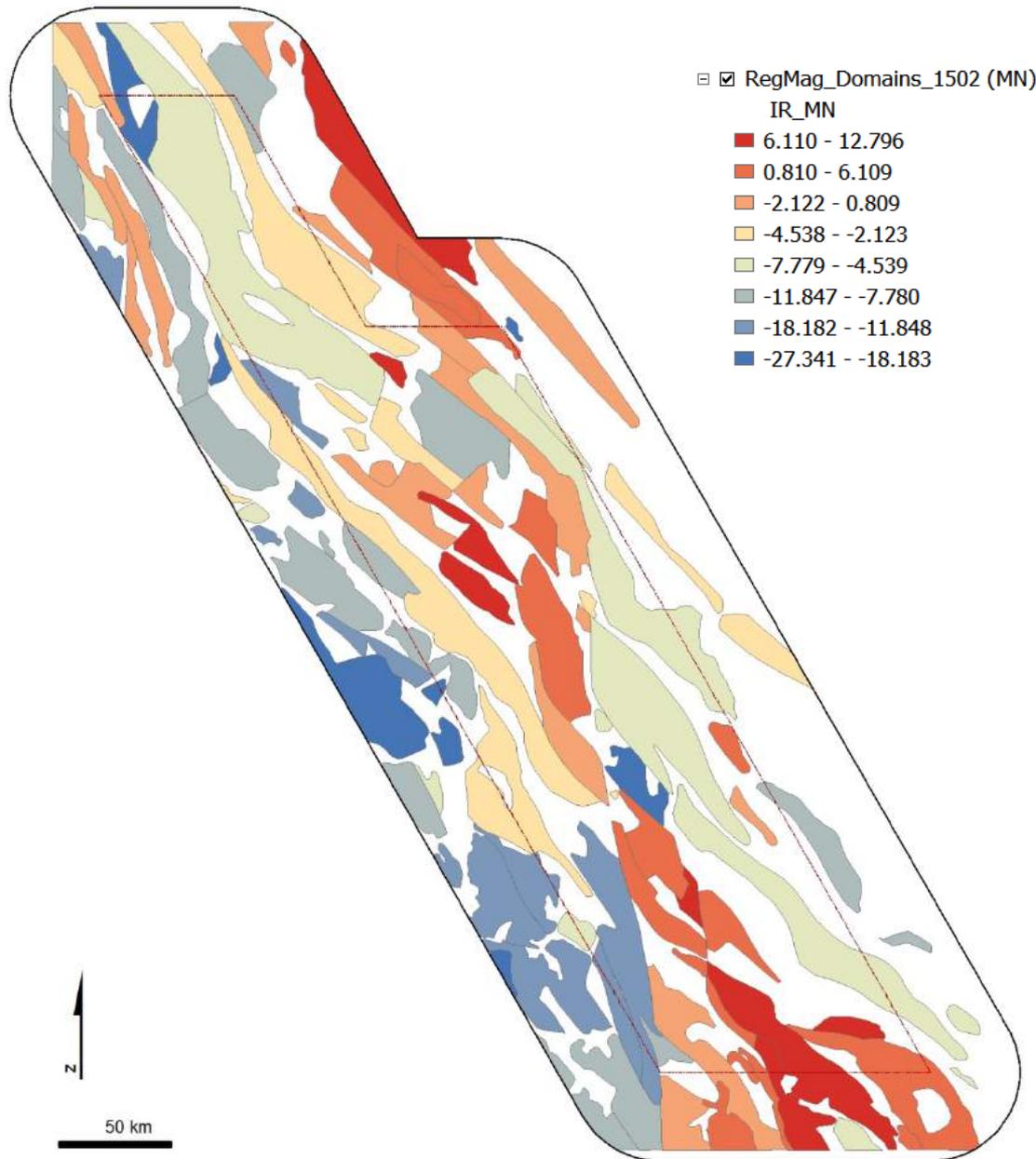
50 km



Major aeromagnetic domains statistics

Quantitative classification

Isostatic Residual (IR) gravity grid used for density distribution classification



Major aeromagnetic domains statistics

Quantitative classification

Density distribution contrasts classification

Mean (Mn) for grid cell values contained by polygons:

- Isostatic Residual (IR) gravity grid

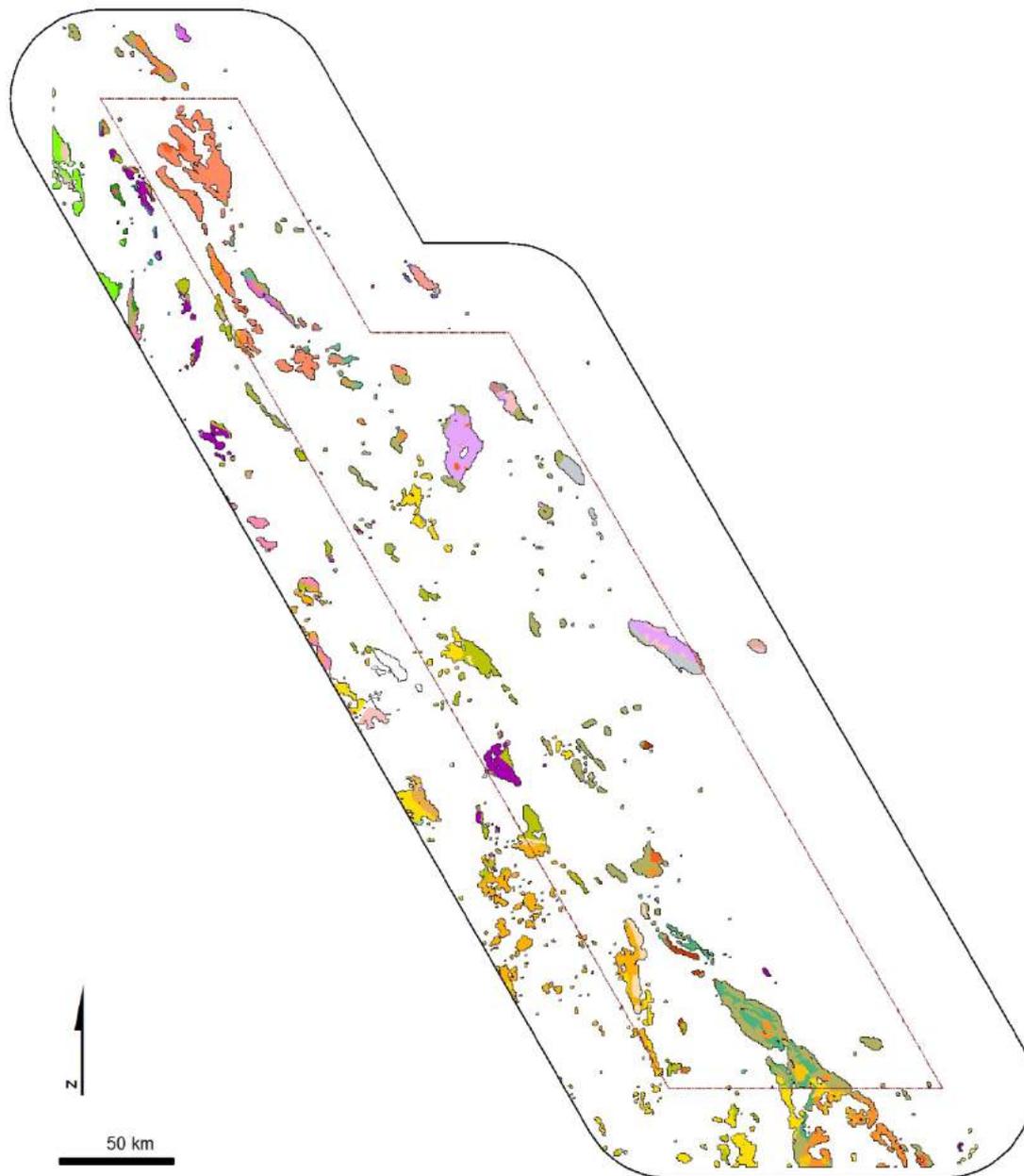
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(NTS SHEETS 093A, B; 093F - K, 093M - O; 094C, D)

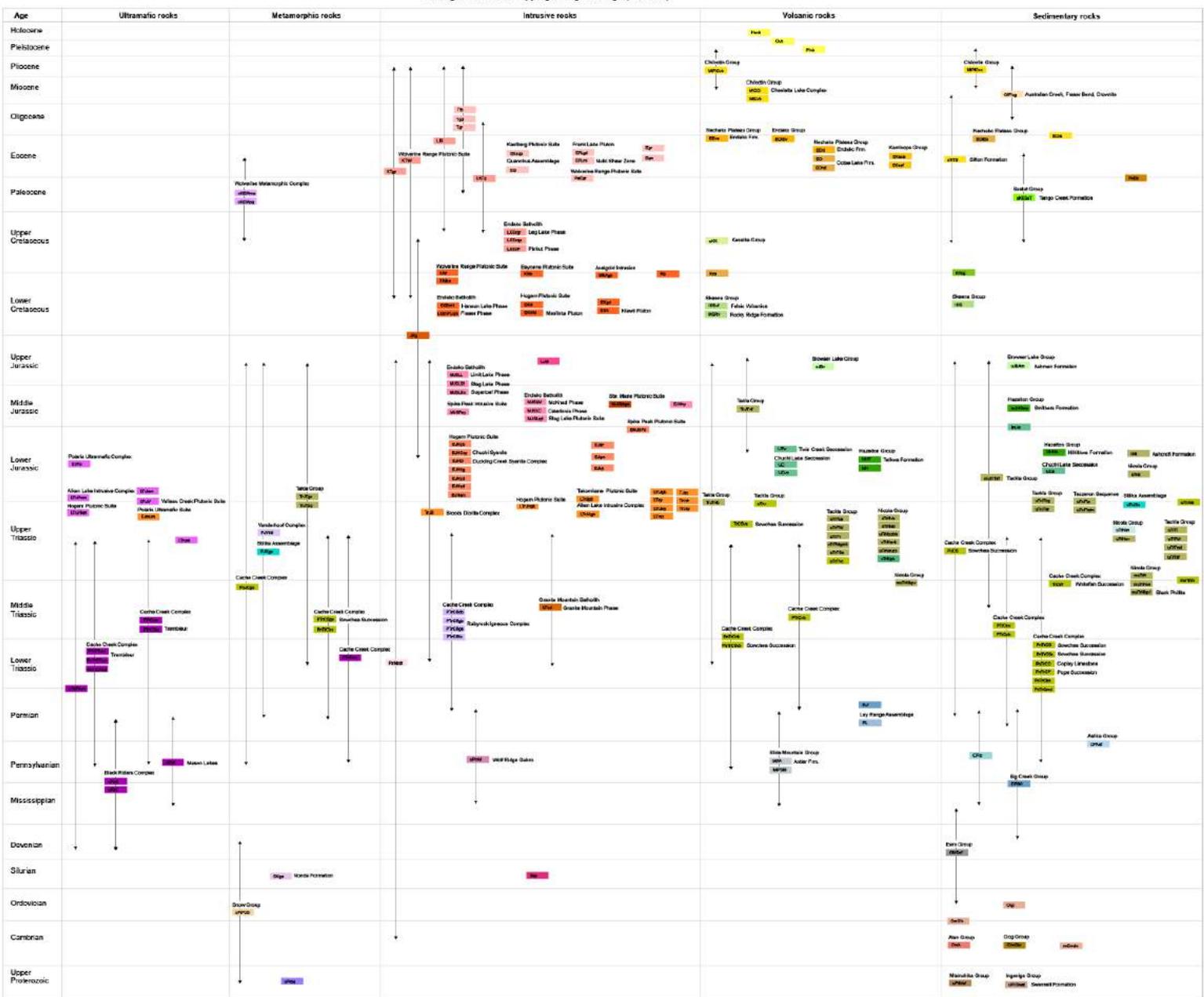
BCGS geology overlapping high intensity magnetic anomalies





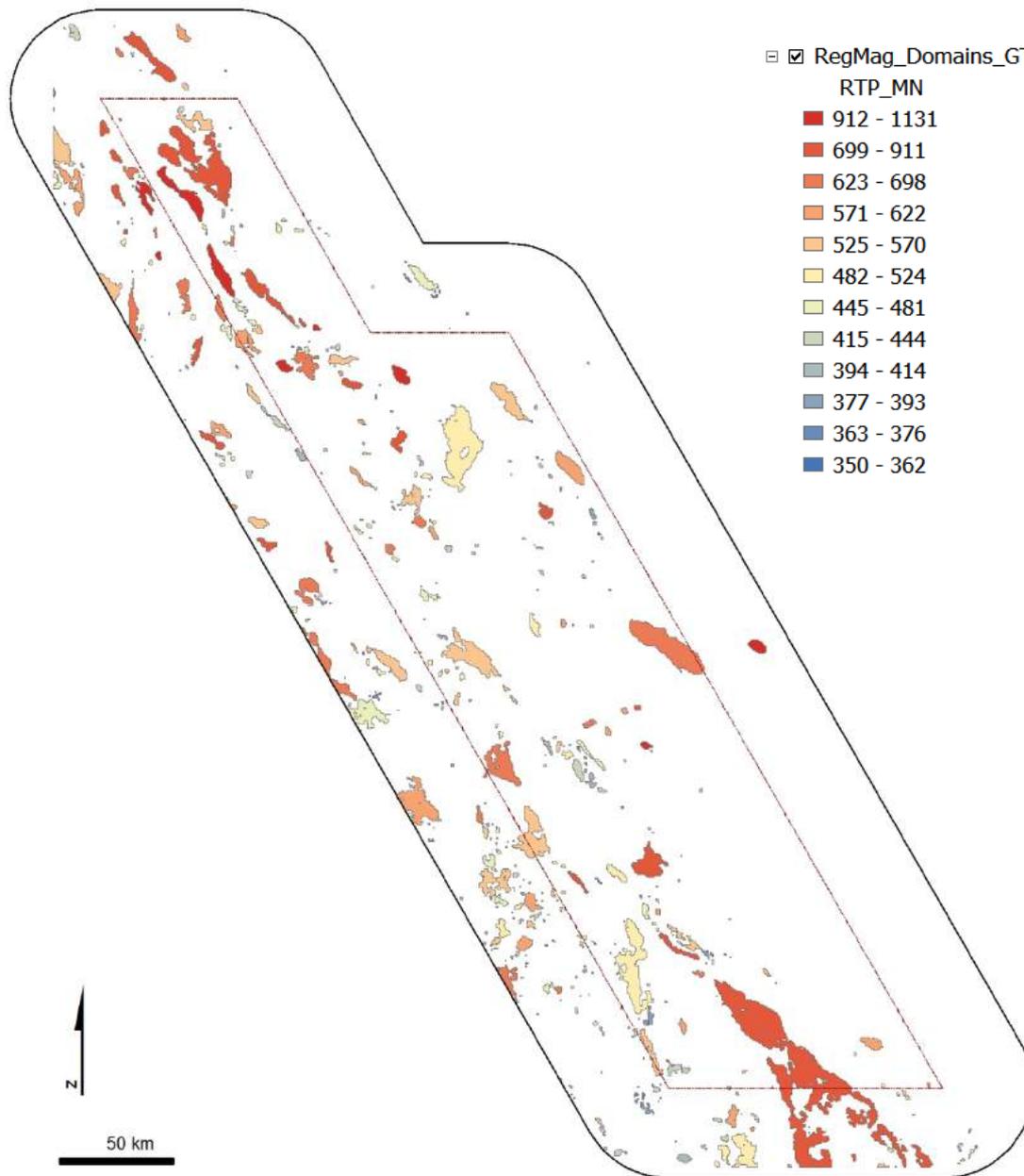
BCGS geology overlapping high intensity magnetic anomalies

- The BCGS Open File 2013-04 map (Cui et al. 2013) was clipped using the RTP magnetic grid with cell-values greater or equal than (GTE) 350 nT
- These geological map units are contained within major magnetic domains and may correspond to the source of high intensity magnetic anomalies
- Database fields included with this data layer correspond to the original British Columbia Geology Survey (BCGS) Open File 2013-04 map (Cui et al. 2013)



Chronostratigraphic Legend

- A chronostratigraphic (time versus rock type) chart includes all geological units from the BCGS geological map (Massey et al. (2005) that overlap high intensity magnetic anomalies (> 350 nT)
- This scheme allows a better link between rock physical properties and rock types, including ultramafic, metamorphic, intrusive, volcanic and sedimentary rocks

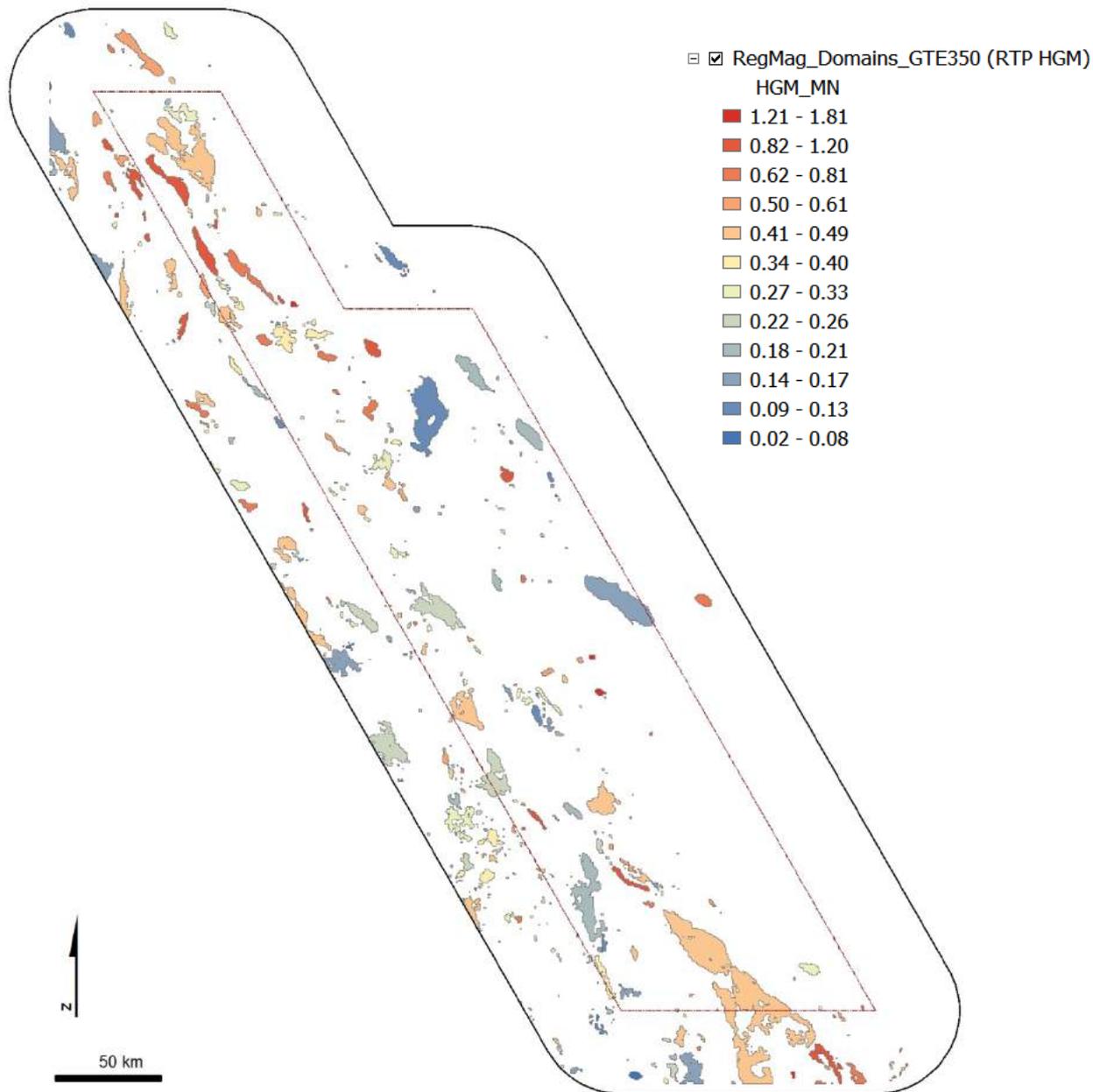


- ☑ RegMag_Domains_GTE350 (RTP)
- RTP_MN
- 912 - 1131
- 699 - 911
- 623 - 698
- 571 - 622
- 525 - 570
- 482 - 524
- 445 - 481
- 415 - 444
- 394 - 414
- 377 - 393
- 363 - 376
- 350 - 362

RTP magnetic anomalies greater than 350nT

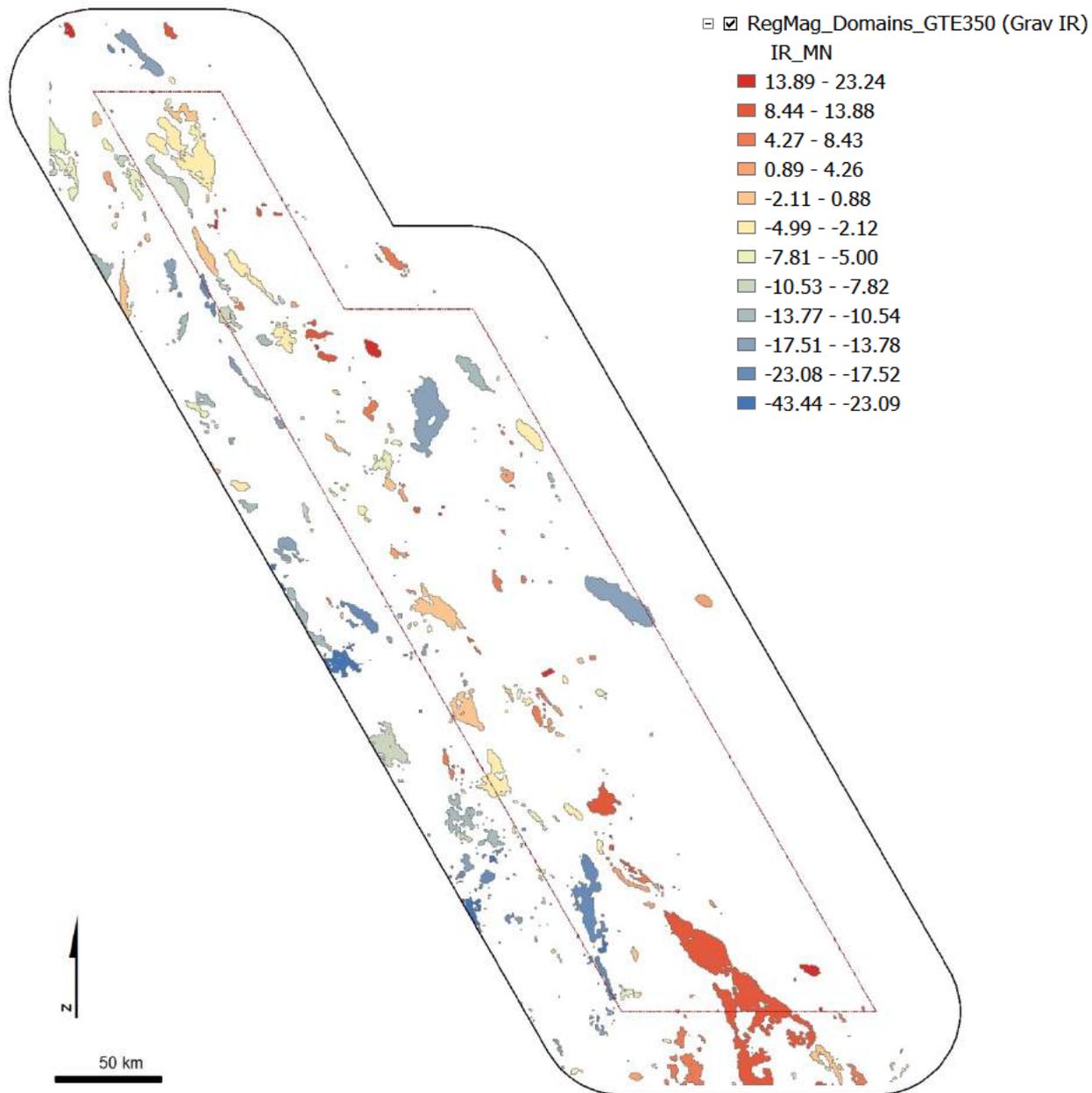
- Mean statistics for polygons with RTP Mag grid-cell values greater or equal than (GTE) 350 nT





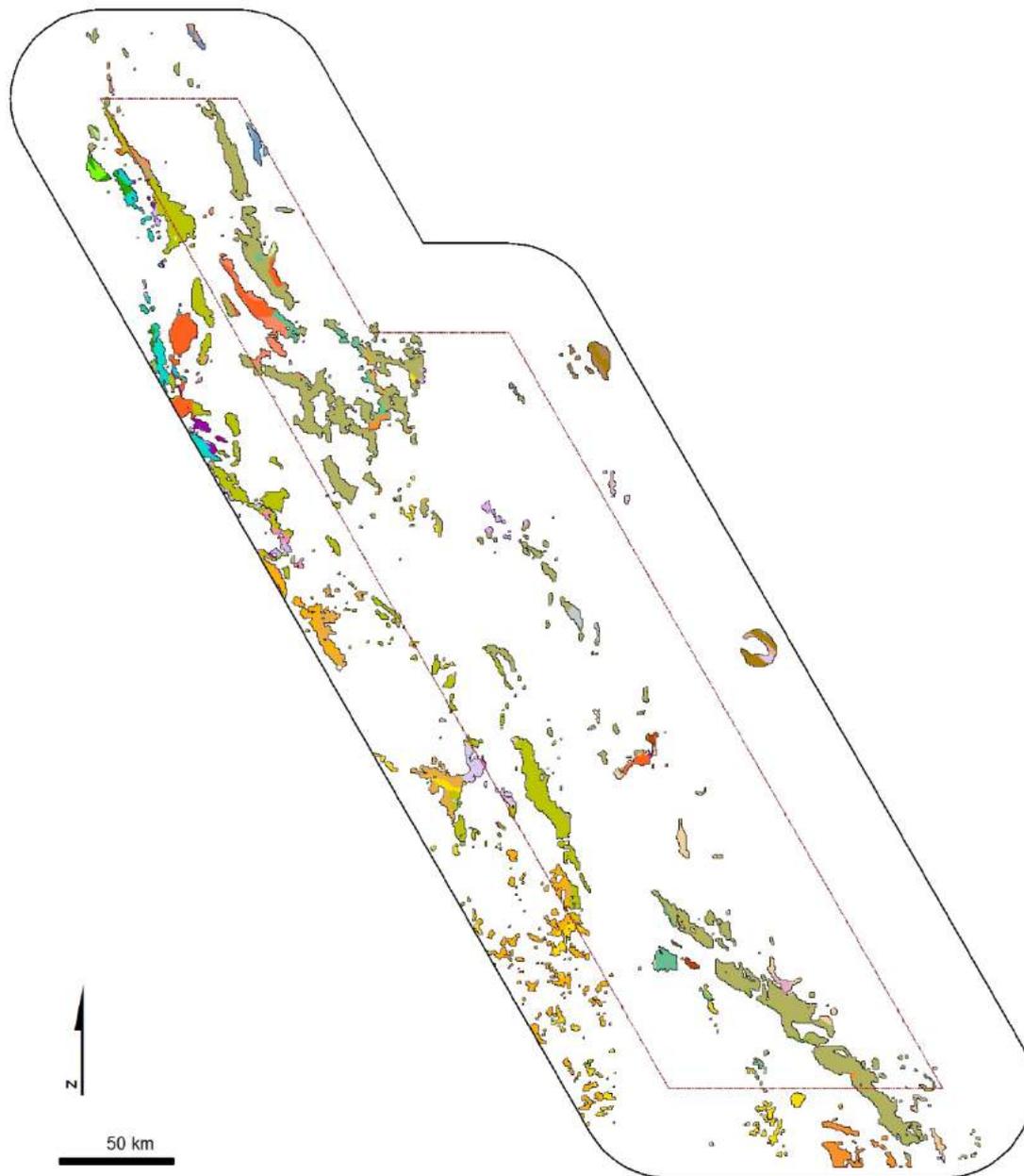
RTP magnetic anomalies greater than 350nT

- Mean statistics from Horizontal Gradient Magnitude (HGM) RTP magnetic grid
- For polygons with RTP Mag grid-cell values greater or equal than (GTE) 350 nT



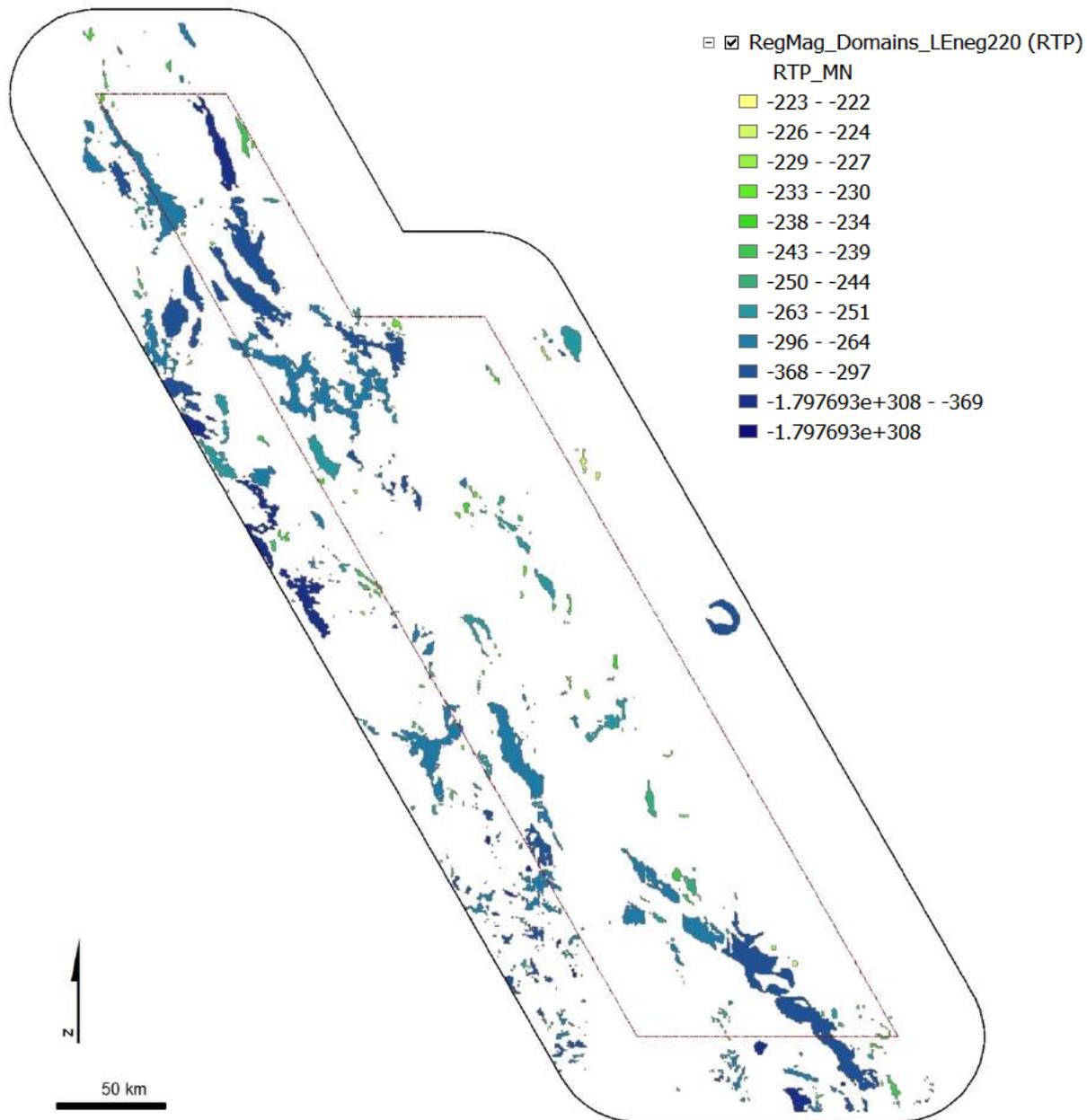
RTP magnetic anomalies greater than 350nT

- Mean statistics from Isostatic Residual (IR) gravity grid
- For polygons with RTP Mag grid-cell values greater or equal than (GTE) 350 nT



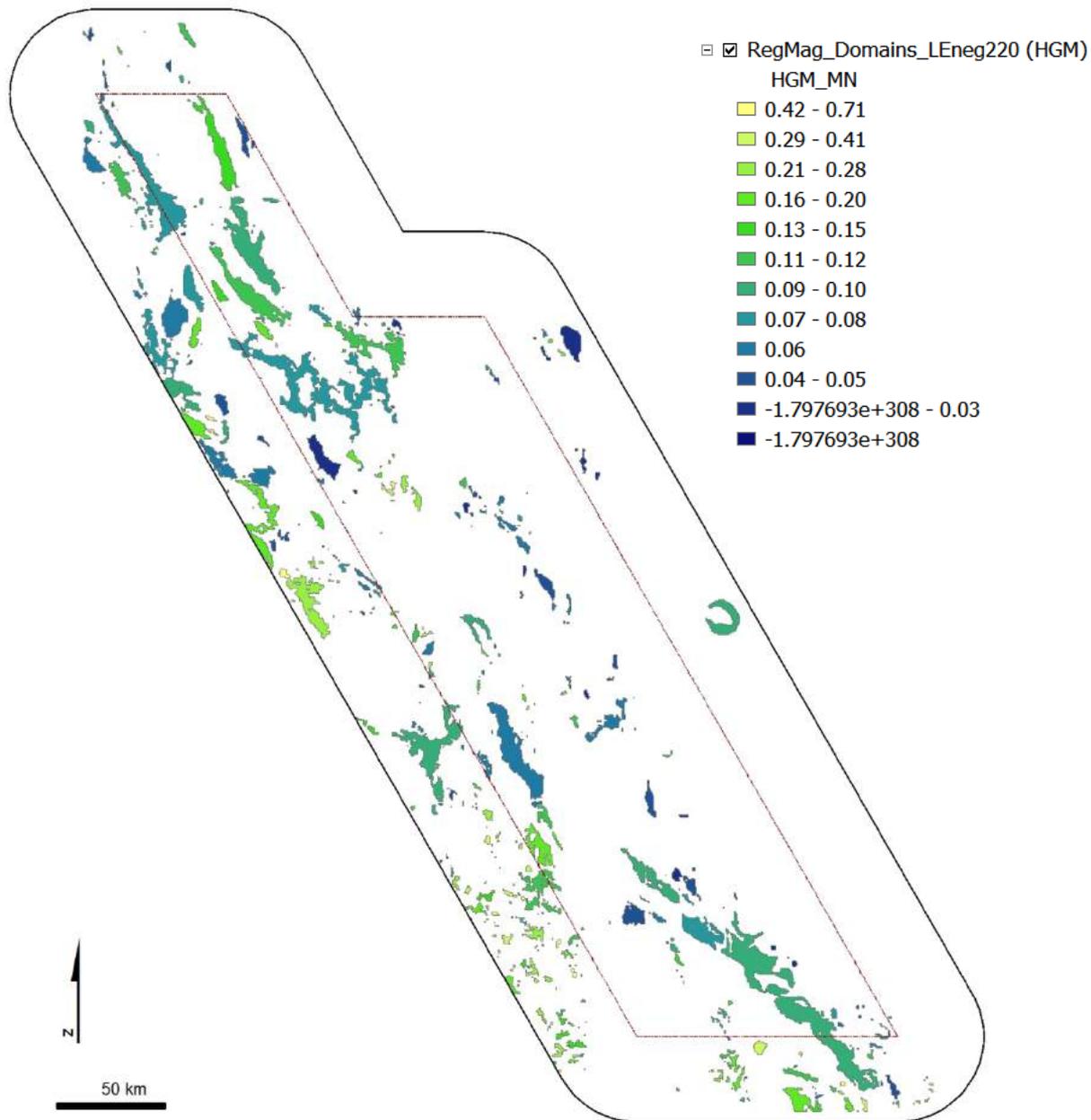
RTP magnetic cells less or equal than - 200 nT

- Geological polygons clipped using RTP Mag grid-cell values less or equal than (LE) -220 nT
- These geological units may correspond to the source of magnetite destructive areas
- Data base fields correspond to the British Columbia Geology Survey (BCGS) Open File 2013-04 map (Cui et al. 2013), which source data was originally released in 2005 (Massey et al., 2005)



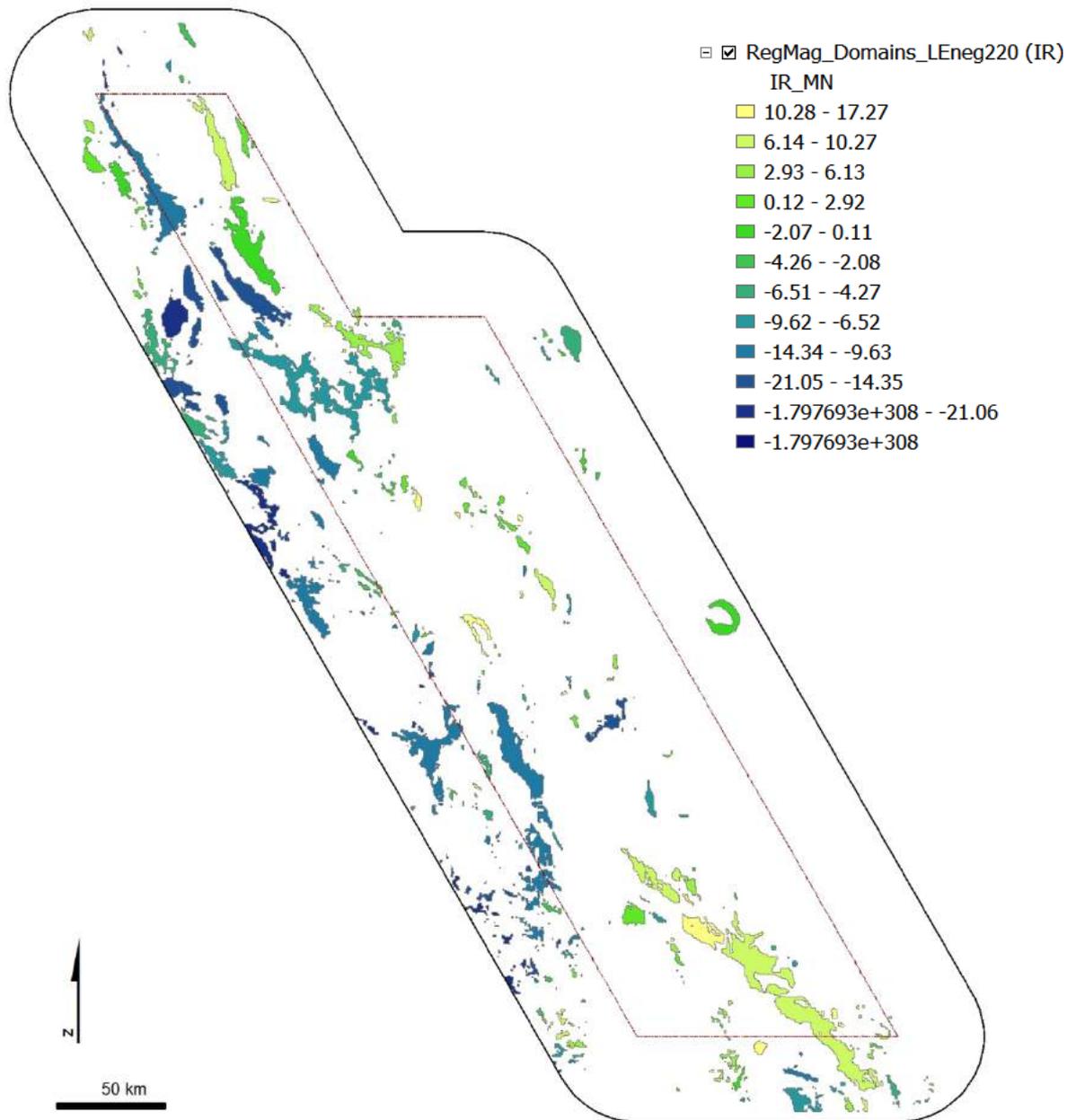
RTP magnetic cells less or equal than -200 nT

- Mean statistics from RTP magnetic grid
- For polygons with RTP Mag grid-cell values less or equal than (LE) -220 nT



RTP magnetic cells less or equal than -200 nT

- Mean statistics from RTP HGM magnetic grid
- For polygons with RTP Mag grid-cell values less or equal than (LE) -220 nT



RTP magnetic cells less or equal than -200 nT

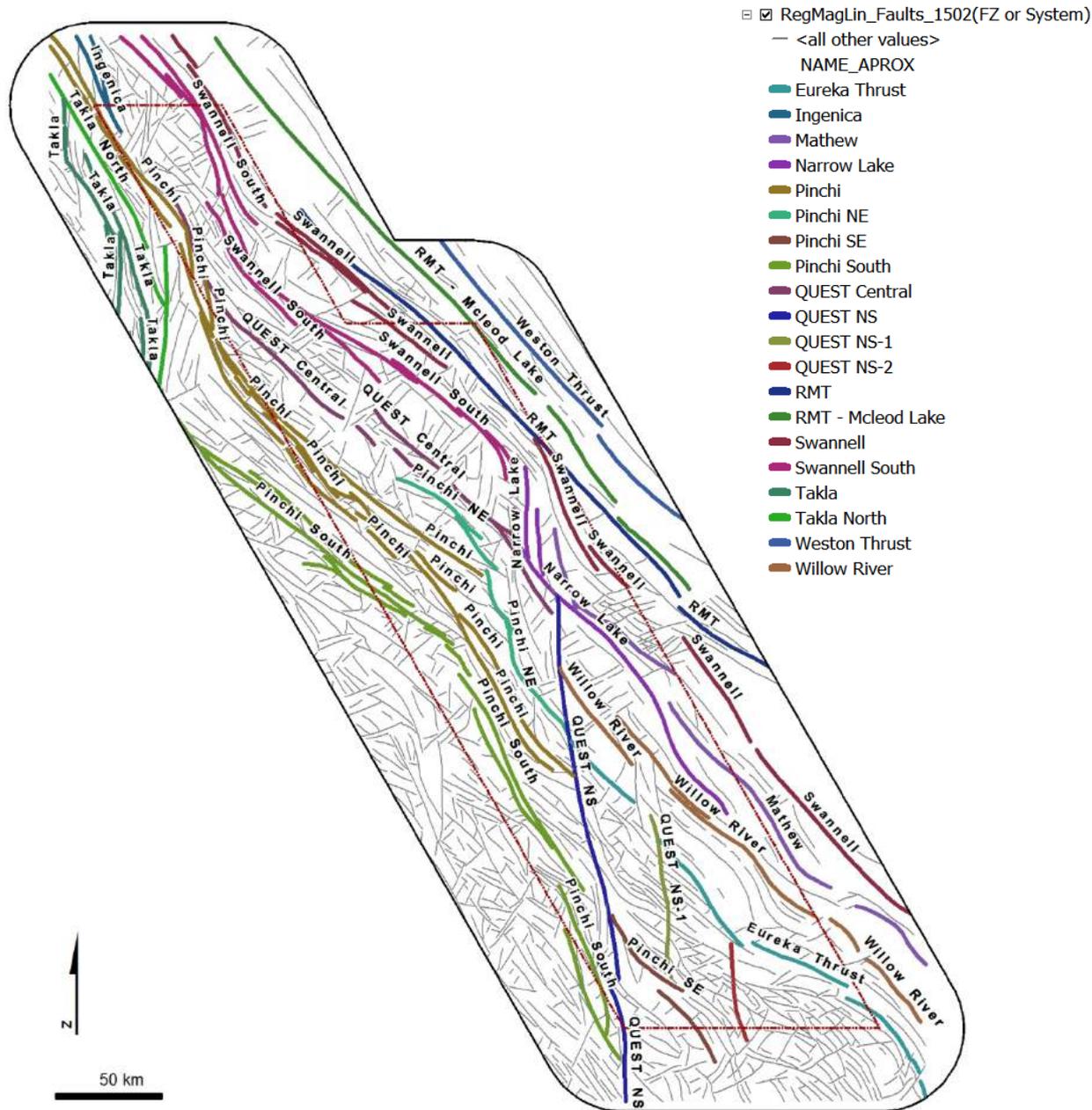
- Mean statistics from IR gravity grid
- For polygons with RTP Mag grid-cell values less or equal than (LE) -220 nT

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(NTS SHEETS 093A, B; 093F - K, 093M - O; 094C, D)

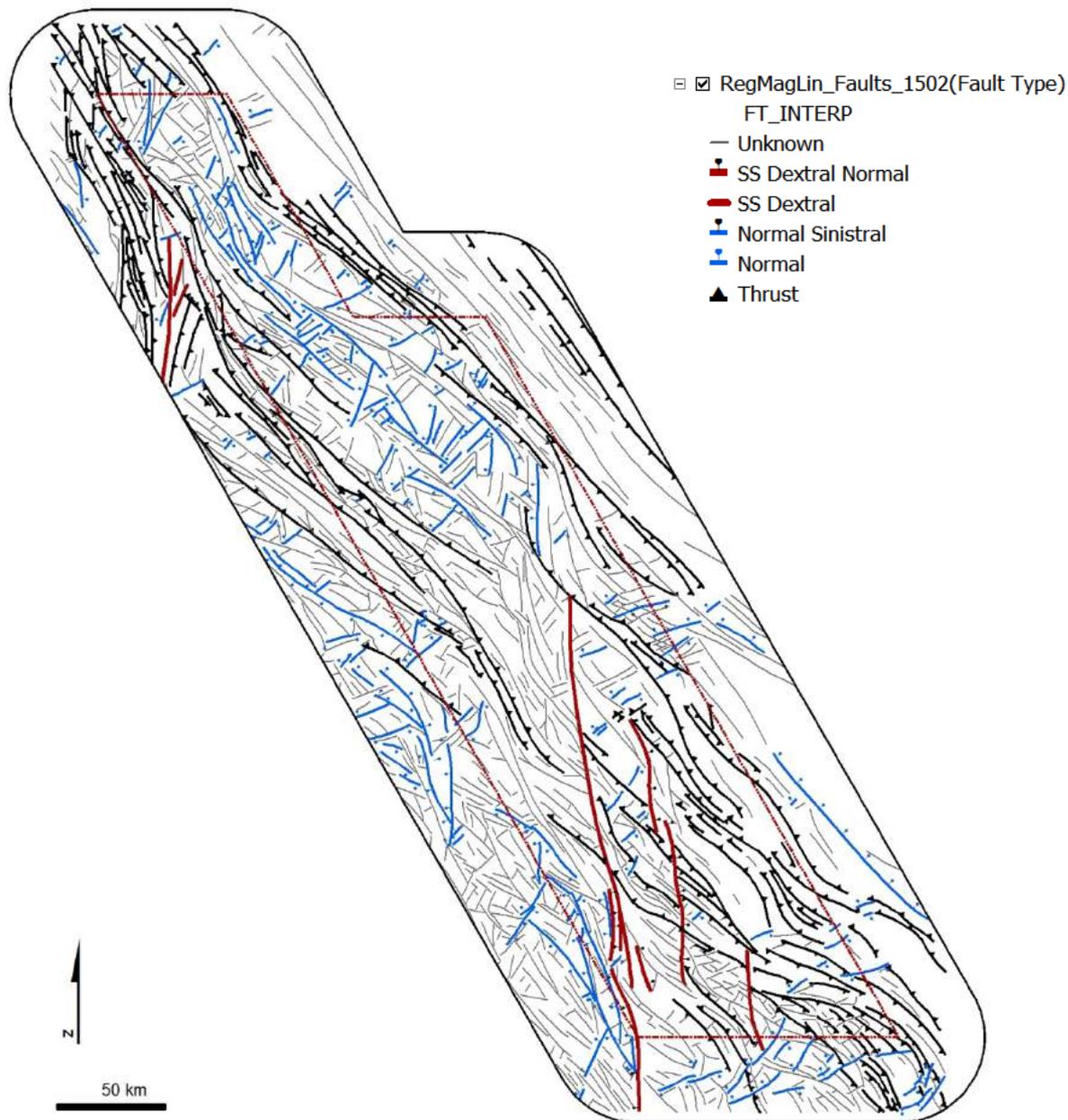
Structural interpretation of aeromagnetic lineaments





Structural Interpretation of Aeromagnetic Lineaments

- Lineament (fault) spatial classification
- Correlation to principal fault systems from the Open File 2013-04 map (Cui et al. 2013)
- Additional mayor lineament (fault) systems



Structural Interpretation of Aeromagnetic Lineaments

Lineament classification into fault types and systems:

- Apparent offsets across magnetic domains were assessed against known structural types

Interpretation reliability:

- Proximal to mapped faults from the BCGS Open File 2013-04
- Interpretation of geological map patterns (BCGS Open File 2013-04), relative offset of magnetic domains and topographic data

Fault systems:

- Spatial correlation to principal faults from the BCGS Open File 2013-04
- New fault systems have been added

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Summary map



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