AIRBORNE ELECTROMAGNETIC AND MAGNETIC SURVEY, GOLDSTREAM CREEK WATERSHED, INTERIOR ALASKA

Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, K., Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd.

Geophysical Report 2016-5

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STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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AIRBORNE ELECROMAGNETIC AND MAGNETIC SURVEY, GOLDSTREAM CREEK WATERSHED, INTERIOR ALASKA

Abraham M. Emond[1], Ronnie P. Daanen[1], Gina R.C. Graham[1], Katey Walter Anthony[2], Anna K. Liljedahl[2], Burke J. Minsley[3], David L. Barnes[4], Vladimir E. Romanovsky[5], and CGG Canada Services Ltd.

ABSTRACT

A National Science Foundation grant to study Arctic hydrology–permafrost–methane systems was awarded to the University of Alaska Fairbanks (UAF), Institute of Northern Engineering, Water and Environmental Research Center with the Alaska Division of Geological & Geophysical Surveys (DGGS) as a co-investigator. As part of the study, DGGS managed the collection, modelling, and interpretation of airborne electromagnetic and magnetic data over a 258-square-km portion of the Goldstream Creek watershed, interior Alaska. The survey was flown from March 6th to March 17th, 2016 by CGG using their RESOLVE airborne geophysical system with a line spacing of either 100 meters (m) or 200 m; additional custom lines were collected over areas of scientific interest. The data were measured from 30 m above the ground surface using a helicopter-towed sensor platform ("bird") on a 30-m long line.

PURPOSE

The UAF and DGGS *Goldstream Valley Watershed* project aims to define processes within the hydrology–permafrost–methane system at the lake to watershed scale, and across seasonal to millennial time scales. Airborne-geophysical datasets were collected to facilitate understanding of surface and subsurface features and processes within Goldstream Valley and surrounding areas of interior Alaska. This sub-arctic region's hydrology–permafrost–methane system contains discontinuous permafrost and thaw lakes and offers a conveniently located and data-rich study area.

SURVEY OVERVIEW DESCRIPTION

This document provides an overview of the survey and includes text and figures of select primary and derivative products of this survey. A table of digital data packages available for download is provided to assist users in data selection. For reference a catalog of the available maps is presented in reduced resolution. Please consult the metadata, project report, and digital data packages for more information and data.

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[3]Geology, Geophysics, and Geochemistry Science Center, U.S. Geological Survey, W 6th Ave., Kipling St., Lakewood, CO 80225

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[5]Geophysical Institute, University of Alaska Fairbanks, 903 Koyukuk Drive, Fairbanks, Alaska 99775

AVAILABLE DATA

Data Type	Provider	Description
ascii_data	contractor	ASCII format line data, other ASCII data
databases_geosoft	contractor	Geosoft format database of final line data, other Geosoft format databases
documents	contractor	Project and field reports, survey background information, gridded data explanations, other documentation
grids_ermapper	DGGS	Geographically registered gridded data, ER Mapper ERS format
grids_geosoft	DGGS	Geosoft-format binary grids, these grids can be viewed in ESRI ArcMap using a free plugin from Geosoft
images_registered	DGGS	GeoTiff format images of all gridded data
kmz	DGGS	kml language kmz archive files of several project data types including resistivity model depth slices
maps_pdf_format	contractor	Printable maps in pdf format
maps_prn_format	contractor	Printable maps in HPGL/G printer file format with extension .prn
outreach_data	DGGS	Data for the general public that requires no specialized software to view. Intended for educational use. Includes resistivity models
vector_data	DGGS	Line path, data contours, and survey boundary in ESRI shape file (SHP) format
photos_flightpath	DGGS	Survey flight path downward facing photos with GPS location in exif data
resistivity_models	DGGS	ACSII CSV format resistivity models in project coordinates with data field guides, figures and supporting documentation in ASCII text, PDF, KML, and/or other formats
video_flightpath	contractor	Survey flight path downward facing video

ACKNOWLEDGMENTS

The *Goldstream Valley Watershed* project is funded by the National Science Foundation, Office of Polar Programs, Arctic System Science Program, award #1500931.

REFERENCES

Ball, L.B., Smith, B.D., Minsley, B.J., Abraham, J.D., Voss, C.I., Astley, B.N., Deszcz-Pan, Maria, and Cannia, J.C., 2011, Airborne electromagnetic and magnetic geophysical survey data of the Yukon Flats and Fort Wainwright areas, central Alaska, June 2010: U.S. Geological Survey Open-File Report 2011-1304, 21 p. https://pubs.usgs.gov/of/2011/1304/

Graham, G.C., Emond, A.M., Daanen, R.P., Minsley, B.J., and CGG, *in press*, Airborne electromagnetic and magnetic survey, Yukon Crossing to Fox profile, interior Alaska: Alaska Division of Geological & Geophysical Surveys Geophysical Report 2016-3, 1 DVD. http://doi.org/10.14509/29684

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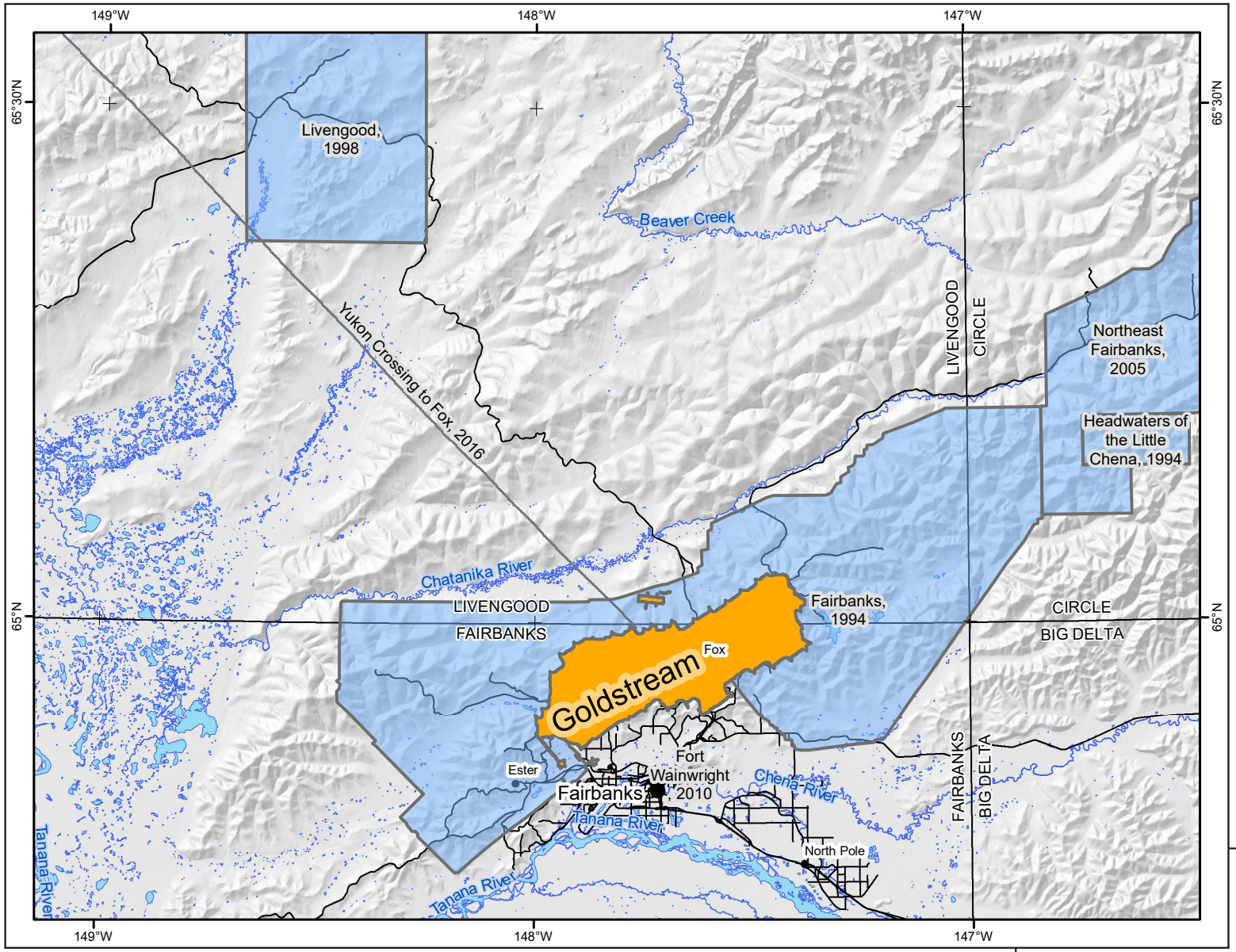
Emond, A.M., Minsley, B.J., Daanen R.P., Graham G.C., and CGG, *in press*, Airborne electromagnetic and magnetic survey, Western Yukon Flats, interior Alaska: Alaska Division of Geological & Geophysical Surveys Geophysical Report 2016-2, 1 DVD. http://doi.org/10.14509/29683



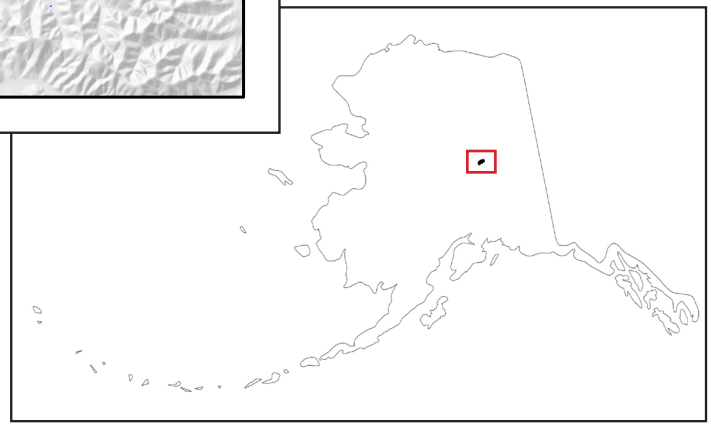


Figure 1. Location map of Goldstream Creek watershed survey area, interior Alaska (inset). Goldstream Creek watershed survey area (orange), nearby and adjacent historical DGGS electromagnetic and magnetic surveys flown at 400-m line spacing (blue), major highways and roads, major rivers, and shaded relief.

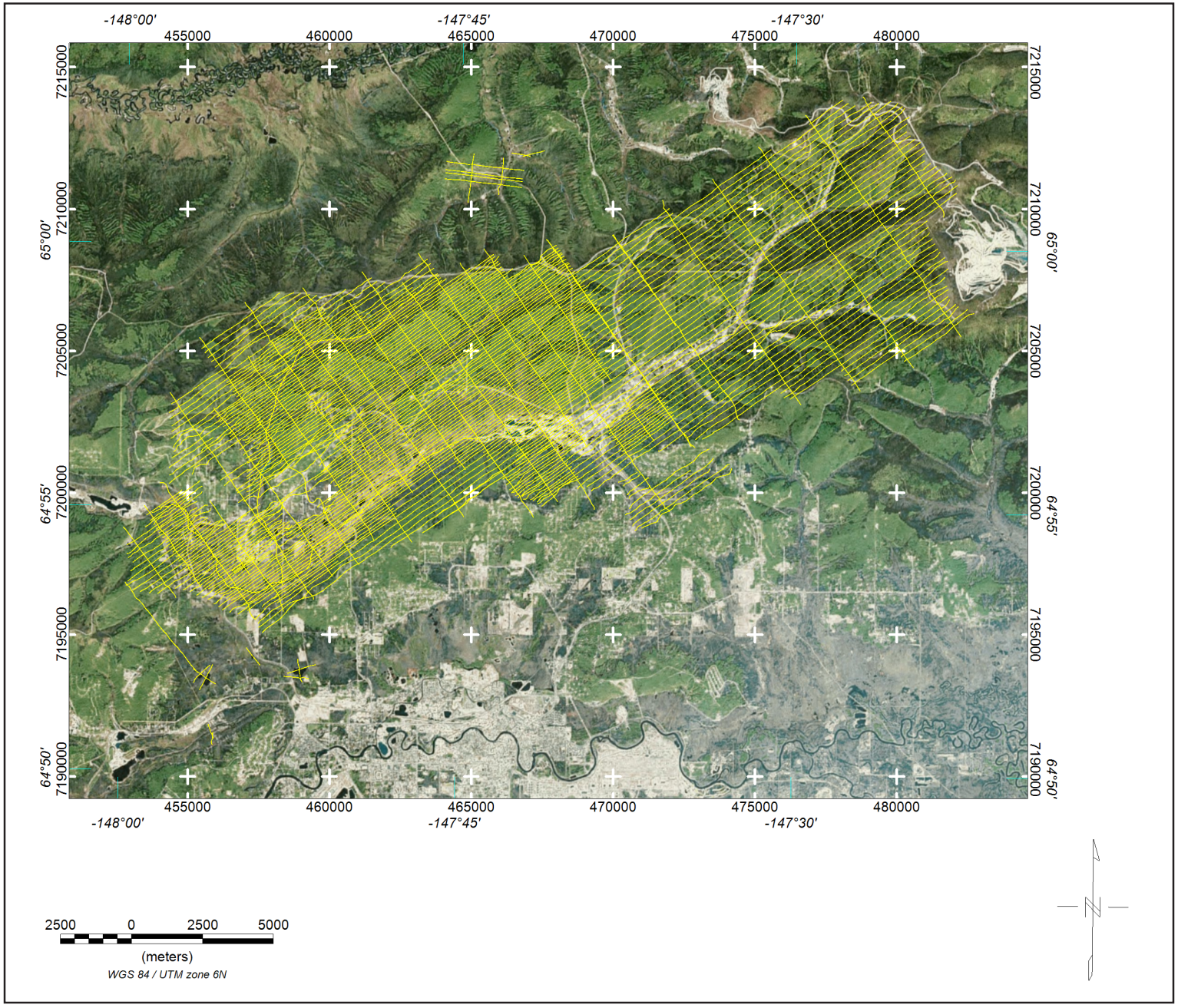


Figure 2. Paths of survey flight lines and wider-spaced perpendicular tie lines with orthophoto of Goldstream Valley.

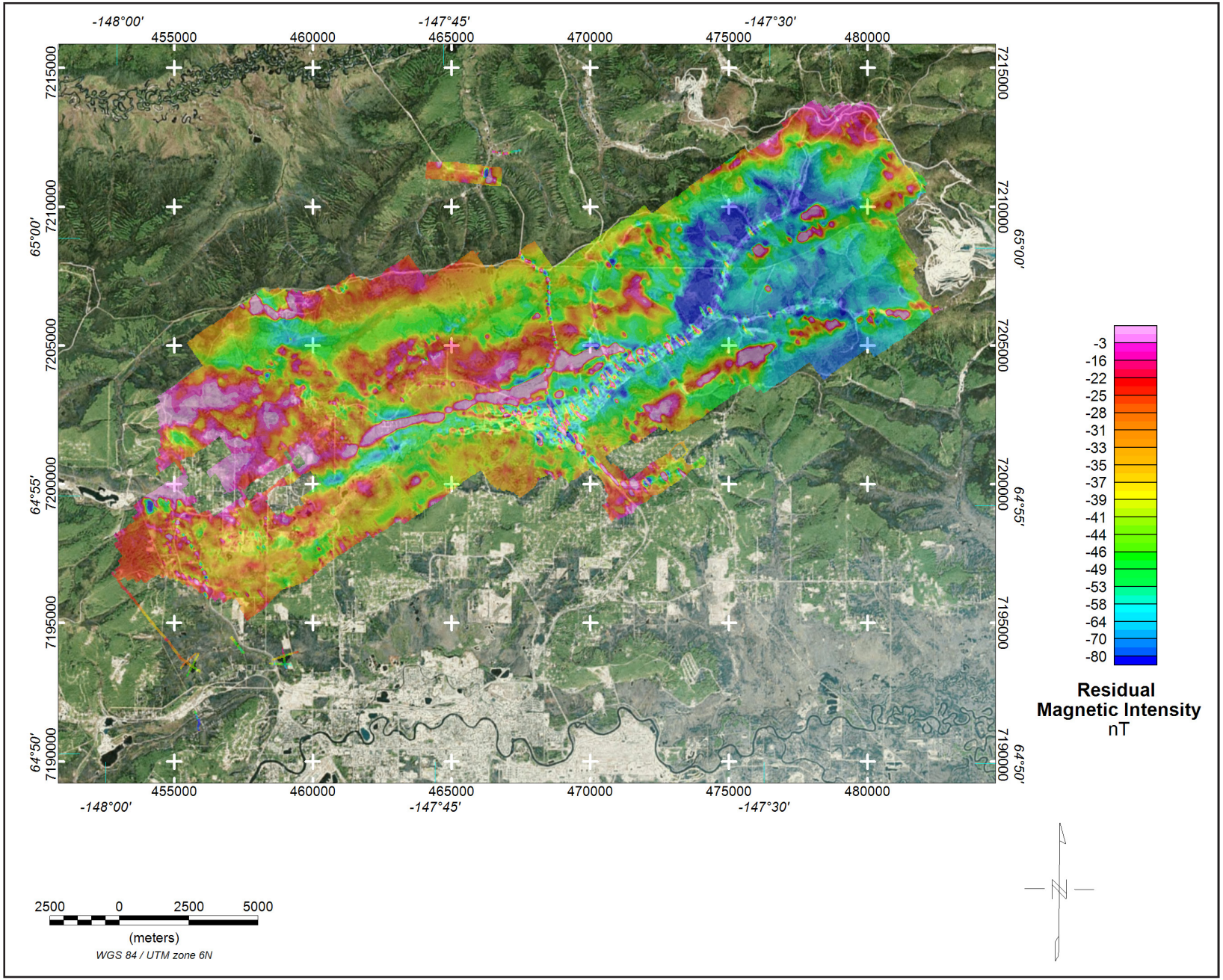


Figure 3. Residual magnetic intensity grid with orthophoto. The magnetic total field data were collected using a Scintrex CS3 cesium sensor at a sampling interval of 0.1 seconds and processed using digitally recorded data from a CGG D1344 base station magnetometer. The magnetic data were: (1) corrected for diurnal variations by subtraction of the base station magnetic data; (2) IGRF corrected (IGRF model 2010, updated for data of flight and altimeter variations); and, (3) leveled using the tie line data.

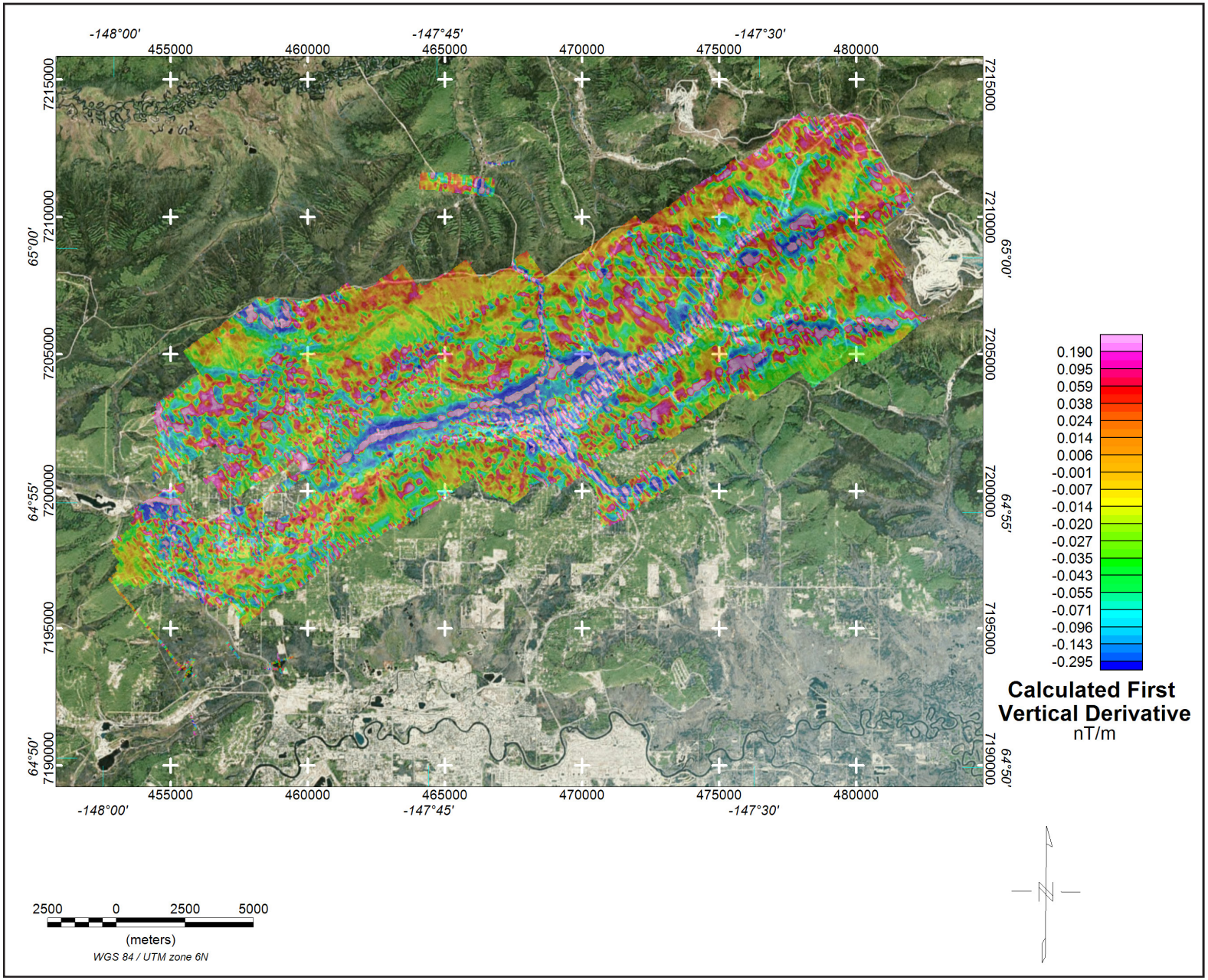


Figure 4. First vertical derivative of the magnetic field grid with orthophoto. The magnetic total field data were collected using a Scintrex CS3 cesium sensor at a sampling interval of 0.1 seconds and processed using digitally recorded data from a CGG D1344 base station magnetometer. The magnetic data were: (1) corrected for diurnal variations by subtraction of the base station magnetic data; (2) IGRF corrected (IGRF model 2010, updated for data of flight and altimeter variations); and, (3) leveled using the tie line data. The first vertical derivative grid was calculated from the processed residual magnetic intensity grid using a Fast-Fourier-Transform (FFT) base frequency domain filtering algorithm. The resulting first vertical derivative grid provides better definition and resolution of near-surface magnetic features and helps to identify weak magnetic features that may not be evident in the residual magnetic data.

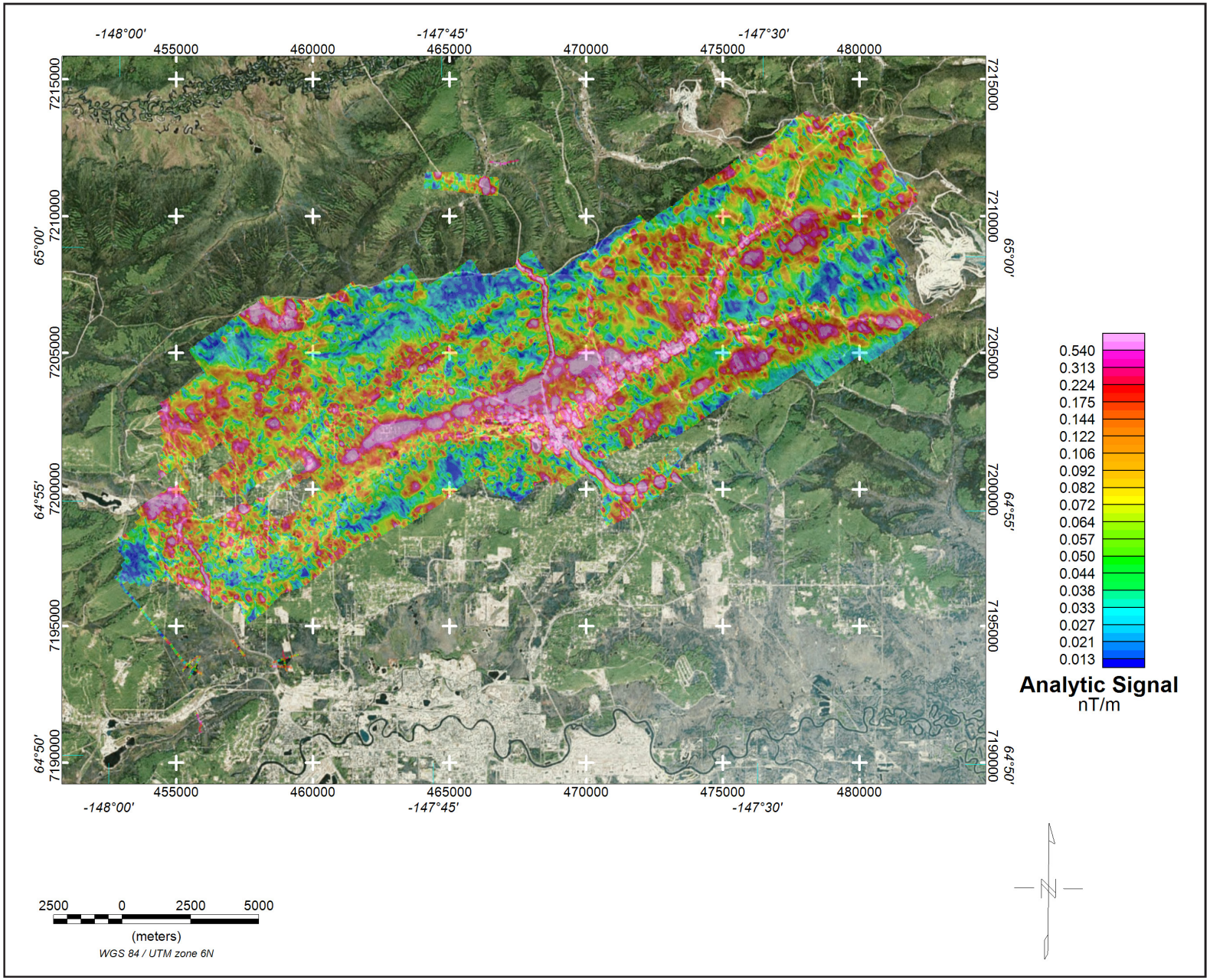


Figure 5. Analytic signal of the magnetic field grid with orthophoto. Analytic signal is the total amplitude of all directions of magnetic gradient calculated from the sum of the squares of the three orthogonal gradients. Mapped highs in the calculated analytic signal of the magnetic parameter locate the anomalous source's edges and corners (such as contacts, fault/shear zones, etc.). Analytic signal enhances the source edges regardless of structural dip and independent of the direction of the induced and/or remanent magnetization.

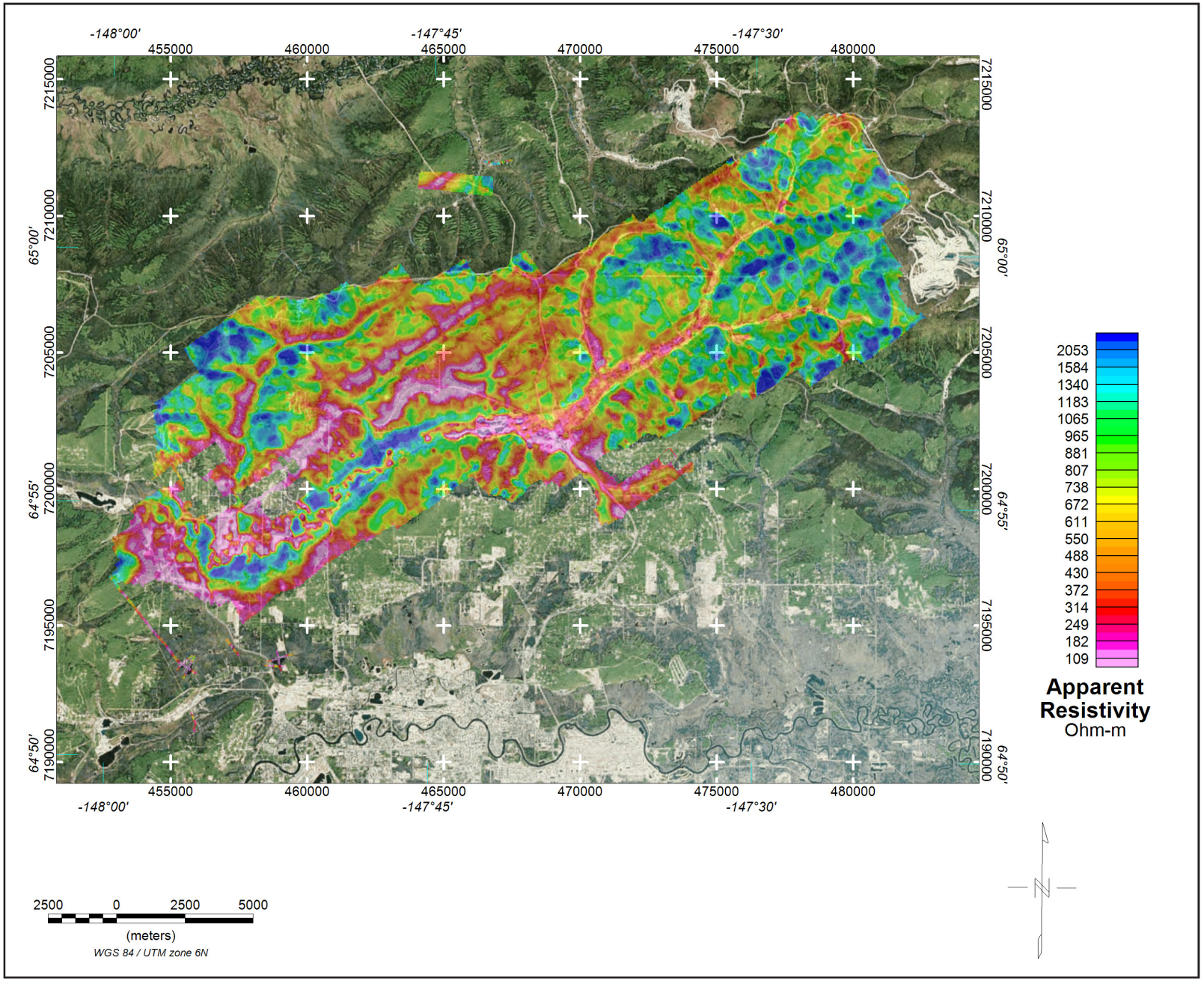


Figure 6. 140,000 hertz (Hz) apparent resistivity grid and orthophoto. The RESOLVE electromagnetic (EM) system operates at six distinct frequencies, and measures the inphase and quadrature components at each frequency. Five coplanar coil pairs operate at 400, 1,800, 8,200, 40,000, and 140,000 Hz (shown), and one coaxial coil pair operates at 3,300 Hz. The EM data were sampled at 0.1 second intervals. The EM system responds to bedrock conductors, conductive overburden, and man-made cultural sources. Apparent resistivity is generated from the inphase and quadrature components for each frequency using the pseudo-layer half-space model.

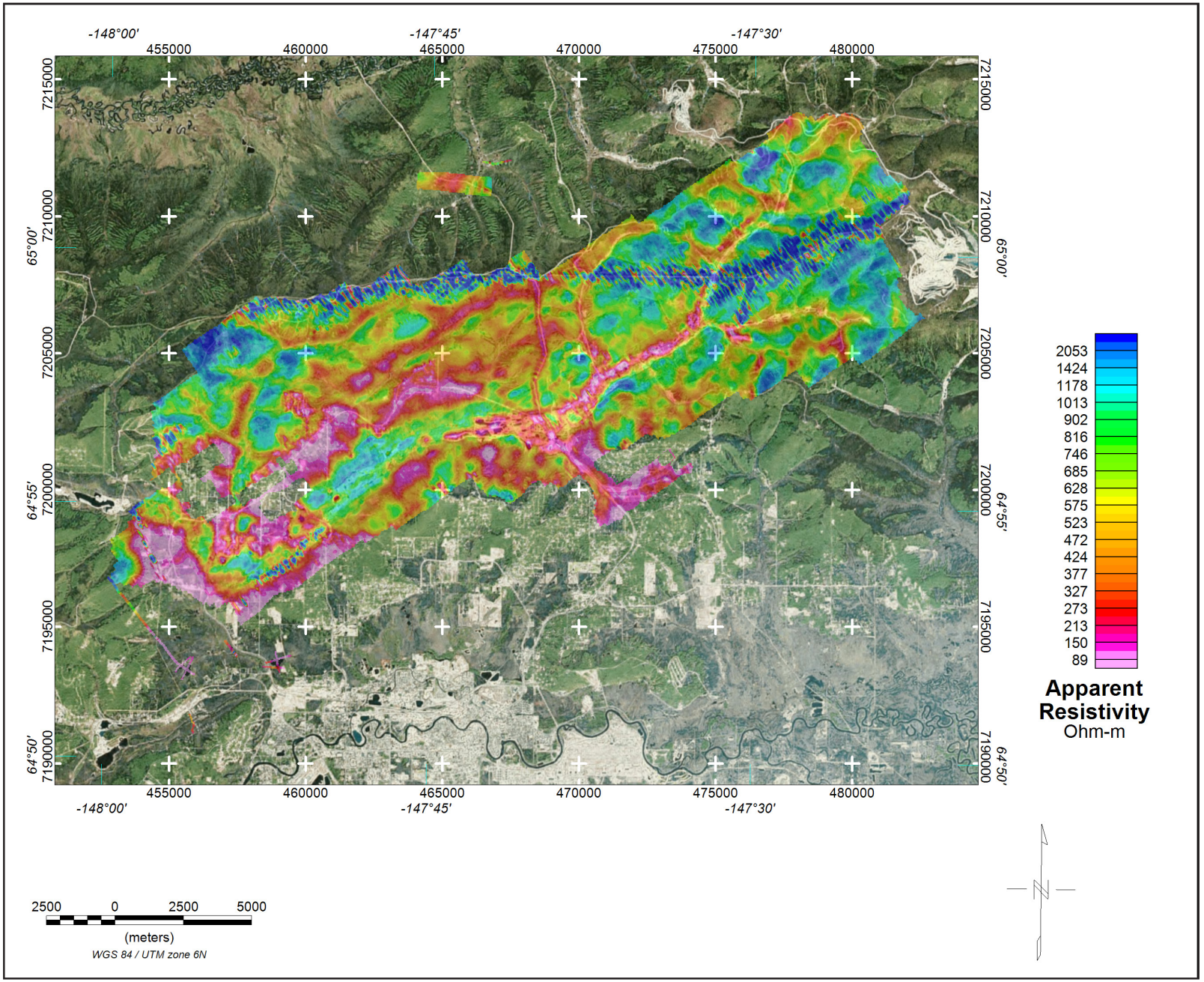


Figure 7. 8,200 Hz apparent resistivity grid and orthophoto. The RESOLVE EM system operates at six distinct frequencies, and measures the inphase and quadrature components at each frequency. Five coplanar coil pairs operate at 400, 1,800, 8,200 (shown), 40,000, and 140,000 Hz, and one coaxial coil pair operates at 3,300 Hz. The EM data were sampled at 0.1 second intervals. The EM system responds to bedrock conductors, conductive overburden, and man-made cultural sources. Apparent resistivity is generated from the inphase and quadrature components for each frequency using the pseudo-layer half-space model.

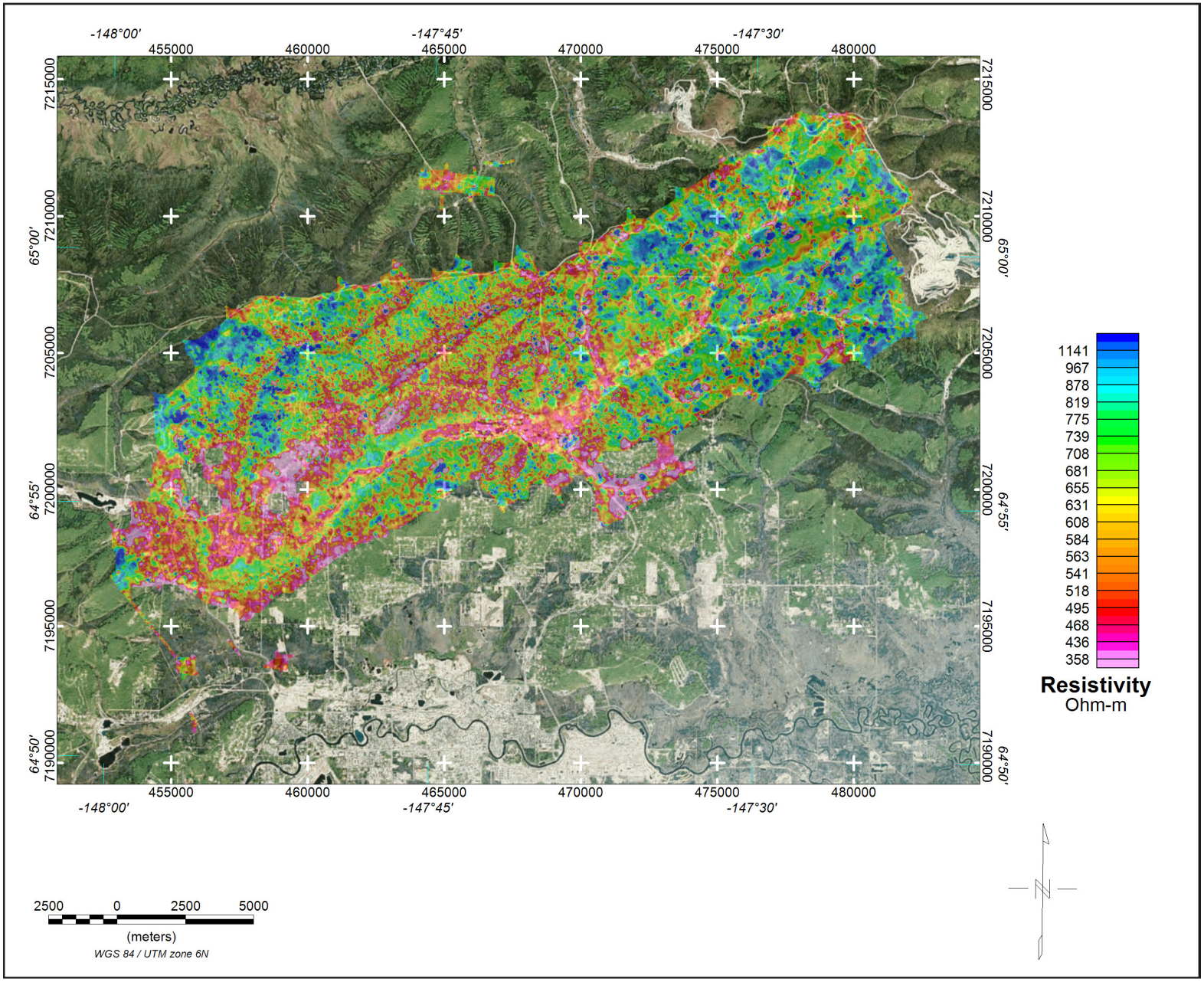


Figure 8. Resistivity model depth-slice grid; at ground surface (first model layer). Resistivity models are created from the recorded electromagnetic data through a process called inversion. Inversion programs create a resistivity model that has a data signature nearly the same as the recorded data. When this occurs the model is said to "fit" the data. This process is non-unique, meaning that many resistivity models could create similar data. The models presented are likely to (but might not) represent the real world distribution of resistivity in the subsurface. The recorded data are influenced by the subsurface on either side of the flight line; therefore, features in the model could be from either side of the flight line. Power lines and other infrastructure can negatively impact the data quality, which could result in missing data and/or cause erroneous models. Resistivity Model "workbench_sci" shown.

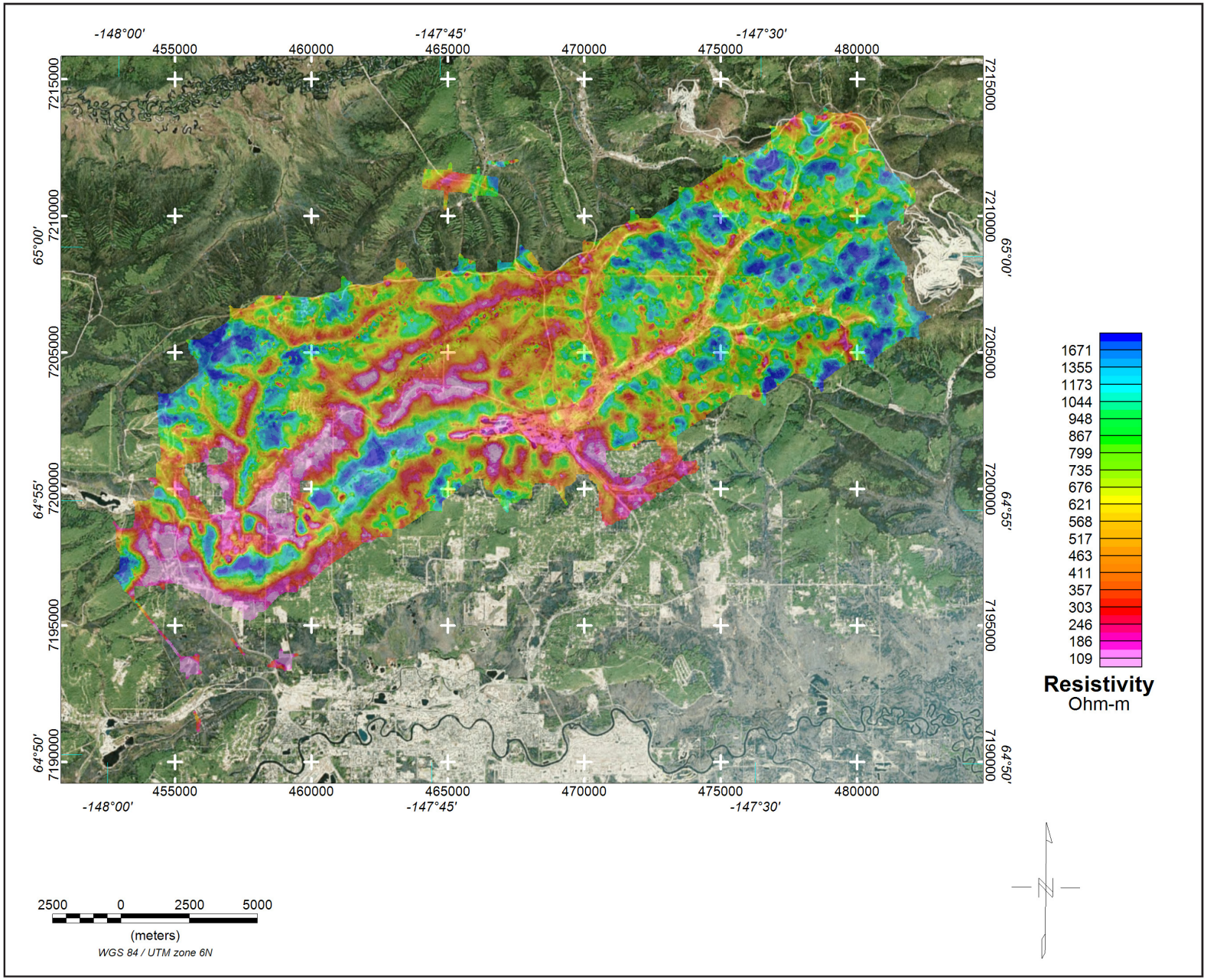


Figure 9. Resistivity model depth-slice grid; 30 meters below ground surface. Resistivity models are created from the recorded electromagnetic data through a process called inversion. Inversion programs create a resistivity model that has a data signature nearly the same as the recorded data. When this occurs the model is said to "fit" the data. This process is non-unique, meaning that many resistivity models could create similar data. The models presented are likely to (but might not) represent the real world distribution of resistivity in the subsurface. The recorded data are influenced by the subsurface on either side of the flight line; therefore, features in the model could be from either side of the flight line. Power lines and other infrastructure can negatively impact the data quality, which could result in missing data and/or cause erroneous models. Resistivity Model "workbench_sci" shown.

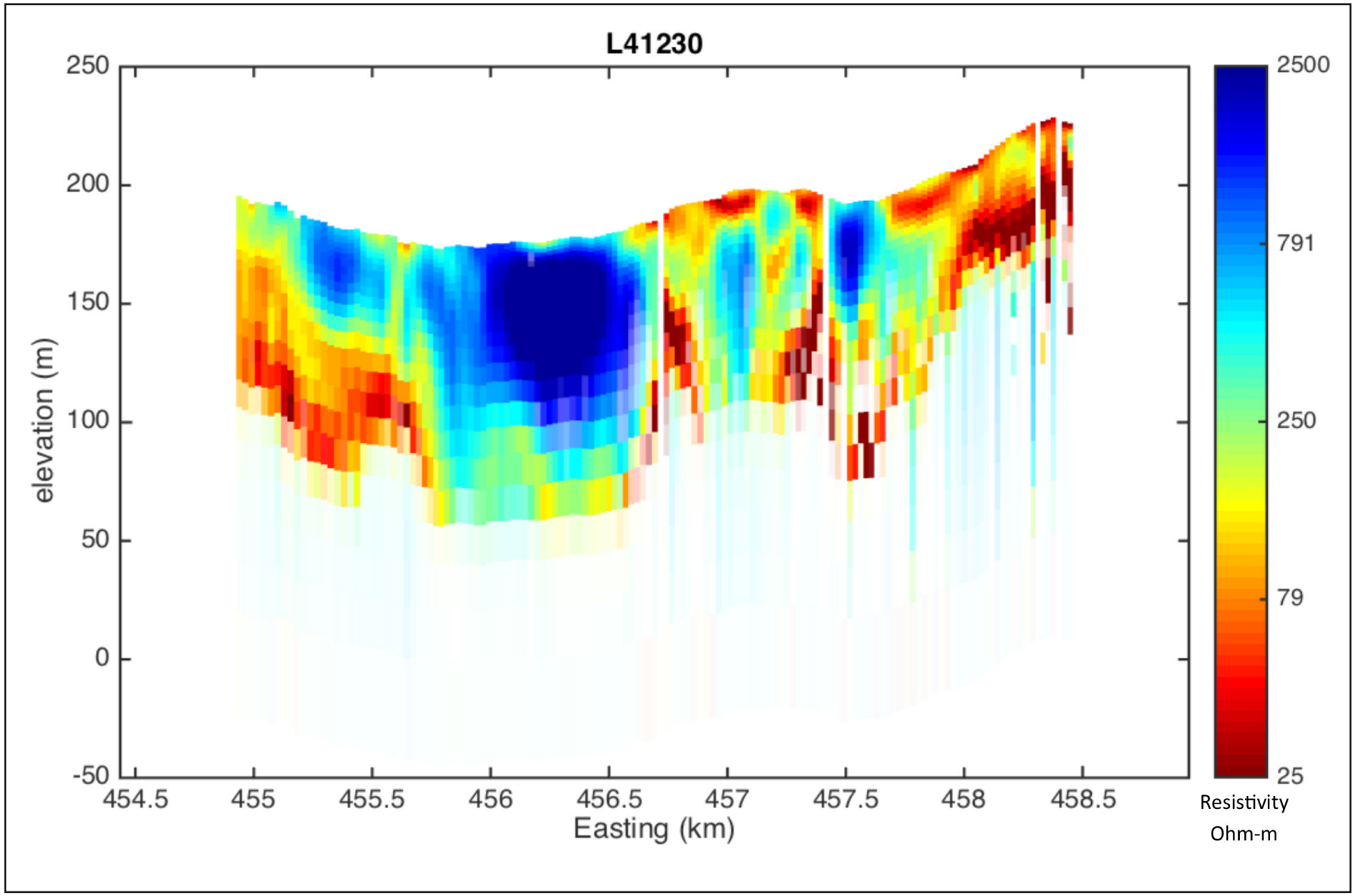


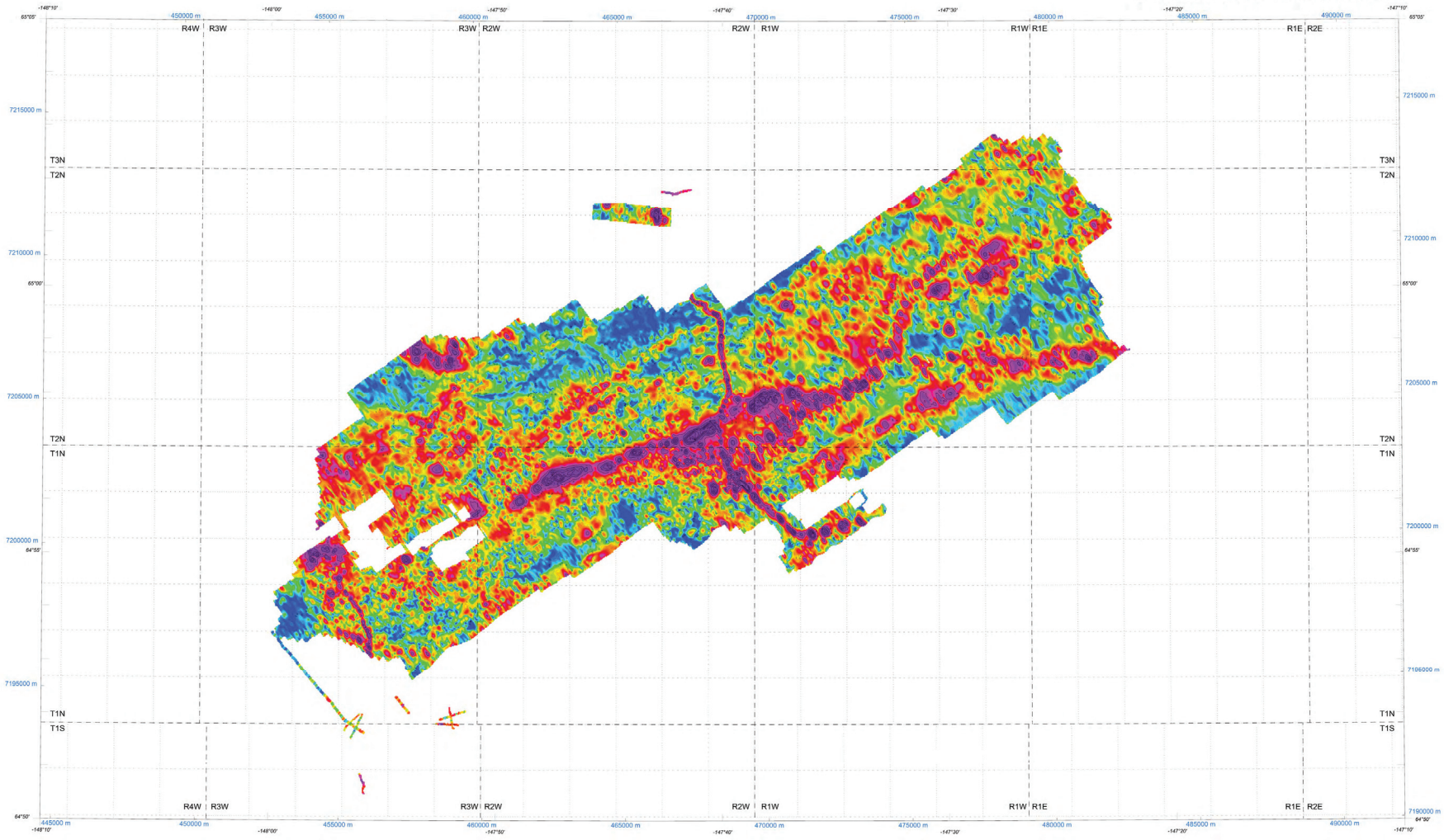
Figure 10. Resistivity model cross section. Resistivity model "em1dfm_prelim" from line 41230 shown. Resistivity models are created from the recorded electromagnetic data through a process called inversion. Inversion programs create a resistivity model that has a data signature nearly the same as the recorded data. When this occurs the model is said to "fit" the data. This process is non-unique, meaning that many resistivity models could create similar data. The models presented are likely to (but might not) represent the real world distribution of resistivity in the subsurface. The recorded data are influenced by the subsurface on either side of the flight line; therefore, features in the model could be from either side of the flight line. Power lines and other infrastructure can negatively impact the data quality, which could result in missing data and/or cause erroneous models.

Table 1. Copies of the following maps are included at the end of this booklet. The low-resolution, page-size maps included in this booklet are intended to be used as a search tool and are not the final product. Large-scale, full-resolution versions of each map are available to download on this publication's citation page: http://doi.org/10.14509/29681.

Map Title	Description
_analyticsignal_contours_map	Analytic signal grid (magnetic data), with township, range, and section background
_analyticsignal_topo_map	Analytic signal grid (magnetic data), with topography background
_calculated1vd_contours_map	Calculated 1st vertical derivative (magnetic data), with township, range, and section background
_calculated1vd_topo_map	Calculated 1st vertical derivative (magnetic data), with topography background
_res140khz_contours_map	140000 Hz coplanar apparent resistivity grid (electromagnetic data), with township, range, and section background
_res140khz_topo_map	140000 Hz coplanar apparent resistivity grid (electromagnetic data), with topography background
_res40khz_contours_map	40000 Hz coplanar apparent resistivity grid (electromagnetic data), with township, range, and section background
_res40khz_topo_map	40000 Hz coplanar apparent resistivity grid (electromagnetic data), with topography background
_res8200hz_contours_map	8200 Hz coplanar apparent resistivity grid (electromagnetic data), with township, range, and section background
_res8200hz_topo_map	8200 Hz coplanar apparent resistivity grid (electromagnetic data), with topography background
_res3300hz_contours_map	3300 Hz coaxial apparent resistivity grid (electromagnetic data), with township, range, and section background
_res3300hz_topo_map	3300 Hz coaxial apparent resistivity grid (electromagnetic data), with topography background
_res1800hz_contours_map	1800 Hz coplanar apparent resistivity grid (electromagnetic data), with township, range, and section background
_res1800hz_topo_map	1800 Hz coplanar apparent resistivity grid (electromagnetic data, with topography background
_res400hz_contours_map	400 Hz coplanar apparent resistivity grid (electromagnetic data), with township, range, and section background
_res400hz_topo_map	400 Hz coplanar apparent resistivity grid (electromagnetic data), with topography background
_residualmag_contours_map	Residual magnetic intensity grid (magnetic data), with township, range, and section background
_residualmag_topo_map	Residual magnetic intensity grid (magnetic data), with topography background

ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

GEOPHYSICAL REPORT 2016-5
ANALYTIC SIGNAL GRID AND CONTOURS WITH TOWNSHIP, RANGE, AND SECTION; SCALE 1:63,360; SHEET 1 OF 1
QUADRANGLES: LIVENGOOD A-1, A-2, FAIRBANKS D-1, D-2



SURVEY LOCATION

DESCRIPTIVE NOTES

This map was derived from data acquired during a CGG RESOLVE electromagnetic and magnetic survey carried out by CGG Canada Services Ltd. The survey was flown from February 20 through March 18, 2016, using an AS350-B2 Ecureuil (Squirrel) helicopter (registration N567NA), flown at a mean terrain clearance of 60 m. The electromagnetic and magnetic data were recorded at 10 Hz using a RESOLVE electromagnetic (EM) system and a Scintrex cesium magnetometer mounted in the EM bird. The EM and magnetic sensors were flown at an optimal height of 30 m. Positioning data were recorded at 2 Hz using Novatel OEM4 Global Positioning System located in both the helicopter and the EM bird. Final flight path was obtained using post-flight differential positioning to a relative accuracy of better than 5 m. Additional equipment on board the helicopter included a radar altimeter, 50/60 Hz monitors, and a video camera. Ground-based systems included Scintrex CS3 and GEM Systems GSM-19 magnetometers and a Novatel OEMSTAR GPS receiver.

Traverse lines were flown approximately northeast/southwest (055°/235°) at a line spacing of 200 m for the main block and infill lines were flown in two blocks for a final line spacing of 100 m in these areas. Tie lines were flown northwest/southeast (145°/325°) with variable line spacing.

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ANALYTIC SIGNAL

Analytic signal is the total amplitude of all directions of magnetic gradient calculated from the sum of the squares of the three orthogonal gradients. Mapped highs in the calculated analytic signal of the magnetic parameter locate the anomalous source edges and corners (such as contacts, fault/shear zones, etc.). Analytic signal enhances the source edges regardless of structural dip and independent of the direction of the induced and/or remanent magnetization.

POWER LINE INTERFERENCE

Power transmission lines affect the EM data to varying degrees dependent on the EM frequency and the power line itself. Many power lines are present within the Goldstream survey block. Whereas most affect the EM data only in close proximity to the power line, severe interference is evident over a wider corridor across some power lines. This is especially evident in the 1800 Hz and 8200 Hz resistivity parameters along a transmission line that extends approximately east/west across the northern edge of the survey block.

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http://doi.org/10.14509/29681

ANALYTIC SIGNAL WITH CONTOURS

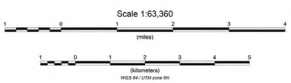
UNIVERSITY OF ALASKA FAIRBANKS

STATE OF ALASKA

NATIONAL SCIENCE FOUNDATION

Inclination: / / 5° N
Declination: 18.2° W
IGRF Model Year: 2015

Scale 1:63,360

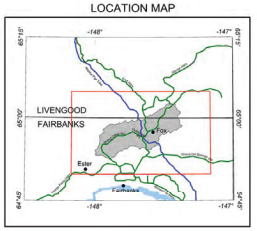


Contour Interval nT/m

0.01
0.02
0.10
0.50

Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, K., Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd.

LOCATION MAP



SURVEY HISTORY

This map has been compiled and drawn under contract between the State of Alaska, Department of Natural Resources, Division of Geological & Geophysical Surveys (DGGS) and CGG Canada Services Ltd.

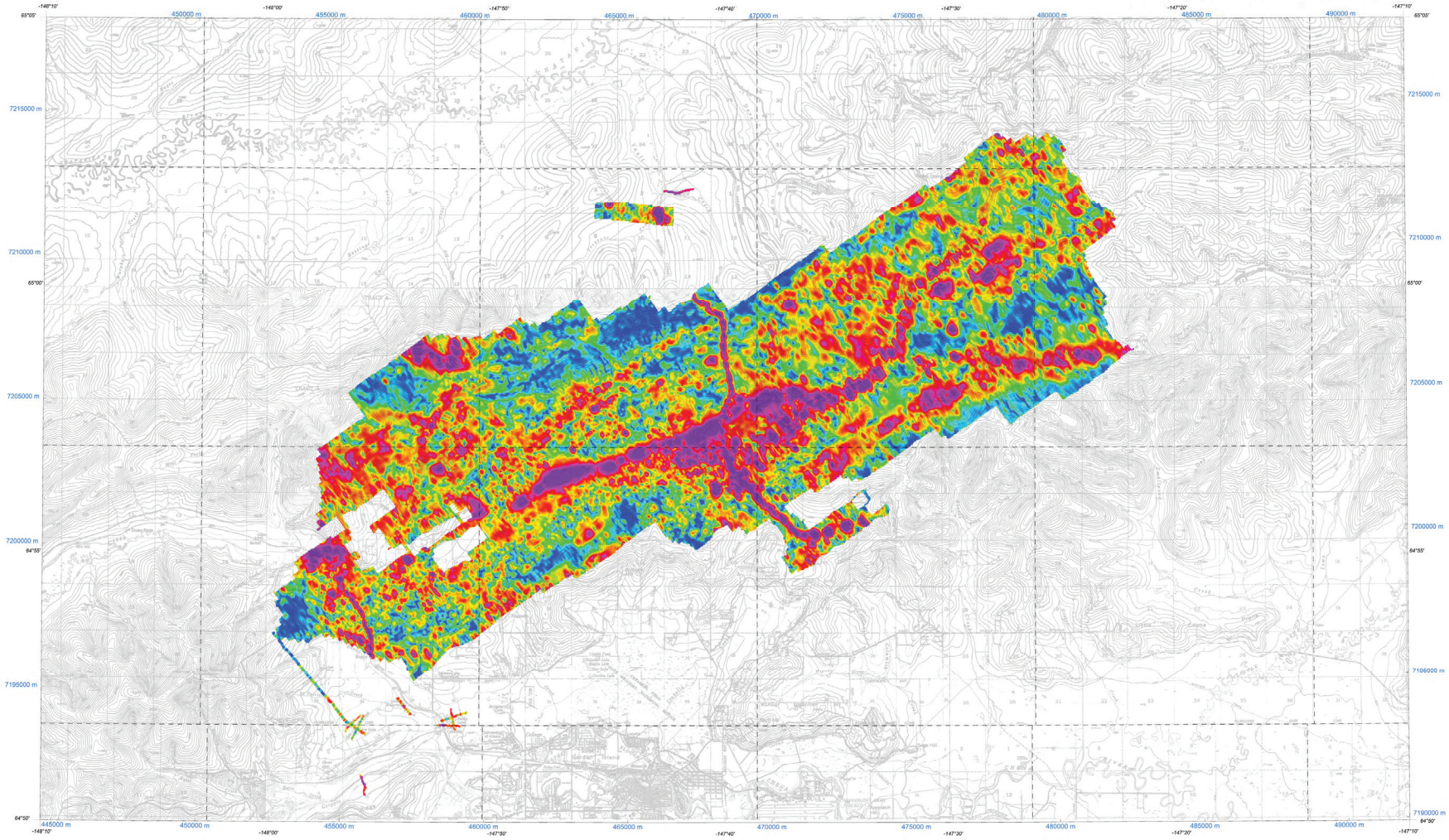
The survey was funded by the National Science Foundation* (NSF) as part of the Goldstream Valley Watershed Project with the University of Alaska Fairbanks Institute of Northern Engineering (INE) Water and Environmental Research Center (WERC).

*National Science Foundation, Office of Polar Programs, Arctic System Science Program, Award #1500931

DGGS acknowledges technical support provided by scientists from the University of Alaska Fairbanks and by scientists from the U.S. Geological Survey Crustal Geophysics and Geochemistry Science Center, Denver, Colorado.

All data and maps produced from this survey are available for download from the DGGS website (http://dggs.alaska.gov). Digital products and paper maps are also available from the DGGS office, 3354 College Road, Fairbanks, Alaska, 99709-3707 (phone 907-451-5010; email: dggspubs@alaska.gov).

GEOPHYSICAL REPORT 2016-5
ANALYTIC SIGNAL GRID WITH TOPOGRAPHY; SCALE 1:63,360; SHEET 1 OF 1
QUADRANGLES: LIVENGOOD A-1, A-2, FAIRBANKS D-1, D-2



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ANALYTIC SIGNAL WITH TOPOGRAPHY

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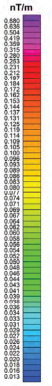
Scale 1:63,360

(miles) 1 0 1 2 3 4

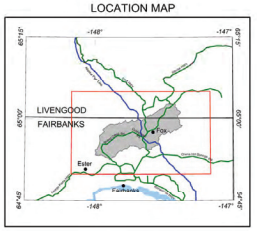
(kilometers) 1 0 1 2 3 4 5

WGS 84 / UTM zone 6N

Inclination: 77.5° N
Declination: 18.2° W
IGRF Model Year: 2015



LOCATION MAP



SURVEY HISTORY

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National Science Foundation, Office of Polar Programs, Arctic System Science Program, Award #1500931

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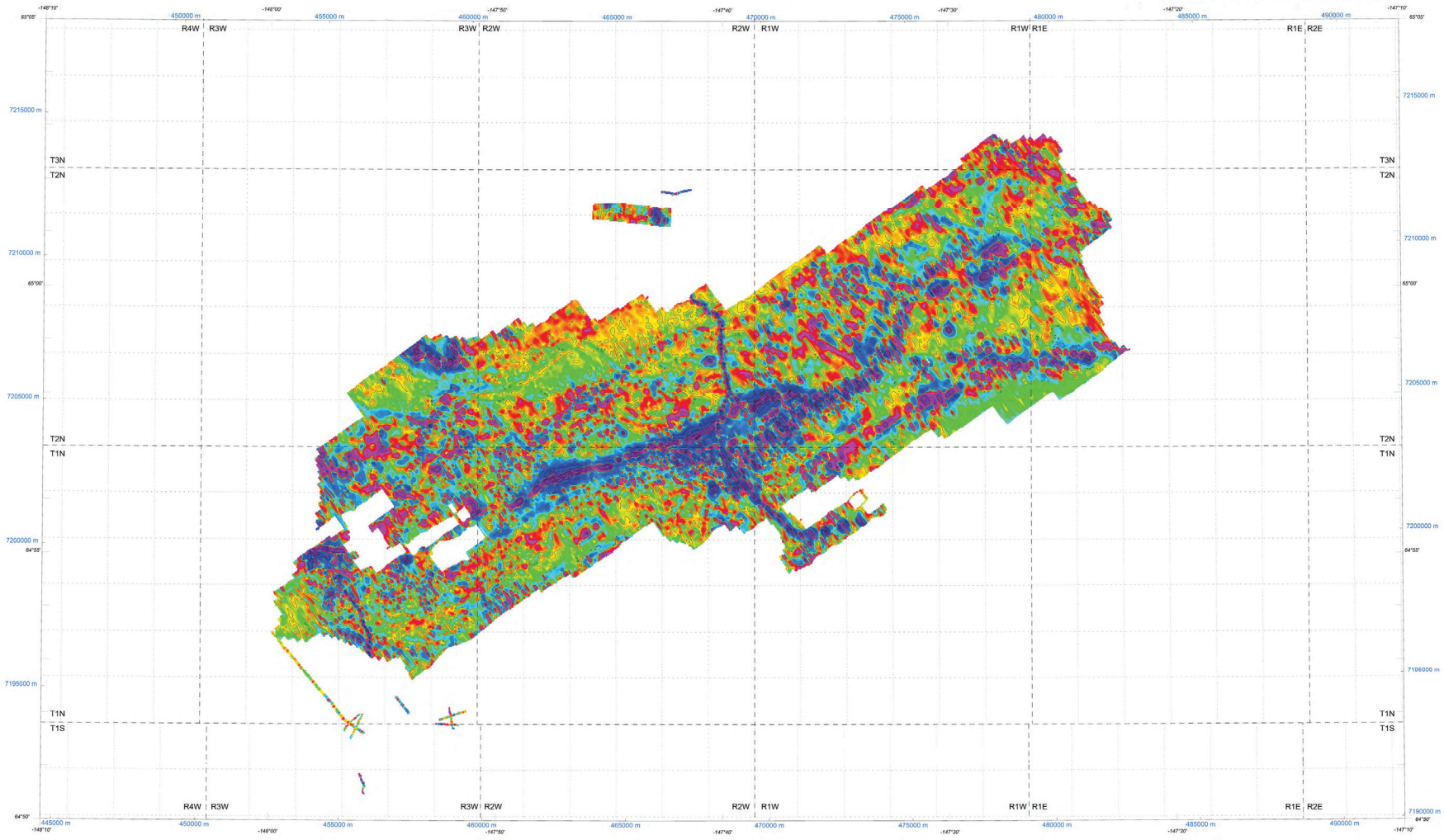
ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

GEOPHYSICAL REPORT 2016-5
FIRST VERTICAL DERIVATIVE OF THE MAGNETIC FIELD GRID AND CONTOURS WITH TOWNSHIP, RANGE, AND SECTION; SCALE 1:63,360; SHEET 1 OF 1
QUADRANGLES: LIVENGOOD A-1, A-2, FAIRBANKS D-1, D-2



SURVEY LOCATION

AIRBORNE ELECTROMAGNETIC AND MAGNETIC SURVEY GOLDSTREAM WATERSHED, INTERIOR ALASKA

http://doi.org/10.14509/29681

FIRST VERTICAL DERIVATIVE OF THE MAGNETIC FIELD WITH CONTOURS

Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, K., Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd.

Scale 1:63,360

(miles) 1 0 1 2 3 4

(kilometers) 1 0 1 2 3 4 5

WGS 84 / UTM zone 6N

TRUE NORTH
MAGNETIC NORTH

Inclination: 77.6° N
Declination: 18.2° W
IGRF Model Year: 2015

Contour Interval nT/m

0.01
0.02
0.10
0.50

nT/m

0.374
0.348
0.183
0.147
0.124
0.105
0.092
0.081
0.073
0.067
0.064
0.062
0.047
0.043
0.039
0.034
0.031
0.029
0.026
0.023
0.020
0.018
0.016
0.013
0.012
0.010
0.009
0.006
0.004
0.002
0.000
-0.002
-0.004
-0.006
-0.008
-0.009
-0.010
-0.012
-0.014
-0.016
-0.018
-0.020
-0.022
-0.024
-0.027
-0.030
-0.033
-0.035
-0.039
-0.044
-0.048
-0.053
-0.061
-0.070
-0.078
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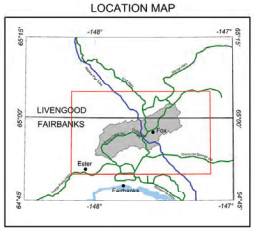
-0.093
-0.105
-0.120
-0.137
-0.167
-0.210
-0.288

LOCATION MAP



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FIRST VERTICAL DERIVATIVE OF THE MAGNETIC FIELD

The magnetic total field data were processed using digitally recorded data from a CGG D1344 base station magnetometer with a Scintrex CS3 cesium sensor. Data were collected at a sampling interval of 0.1 seconds. The magnetic data were (1) corrected for diurnal variations by subtraction of the base station magnetic data, (2) IGRF corrected (IGRF model 2015, updated for data of flight and altimeter variations), and (3) leveled using the tie line data. The first vertical derivative grid was calculated from the processed residual magnetic intensity grid using an FFT base frequency domain filtering algorithm. The resulting first vertical derivative grid provides better definition and resolution of near-surface magnetic units and helps to identify weak magnetic features that may not be evident in the residual magnetic data.

POWER LINE INTERFERENCE

Power transmission lines affect the EM data to varying degrees dependent on the EM frequency and the power line itself. Many power lines are present within the Goldstream survey block. Whereas most affect the EM data only in close proximity to the power line, severe interference is evident over a wider corridor across some power lines. This is especially evident in the 1800 Hz and 8200 Hz resistivity parameters along a transmission line that extends approximately east/west across the northern edge of the survey block.

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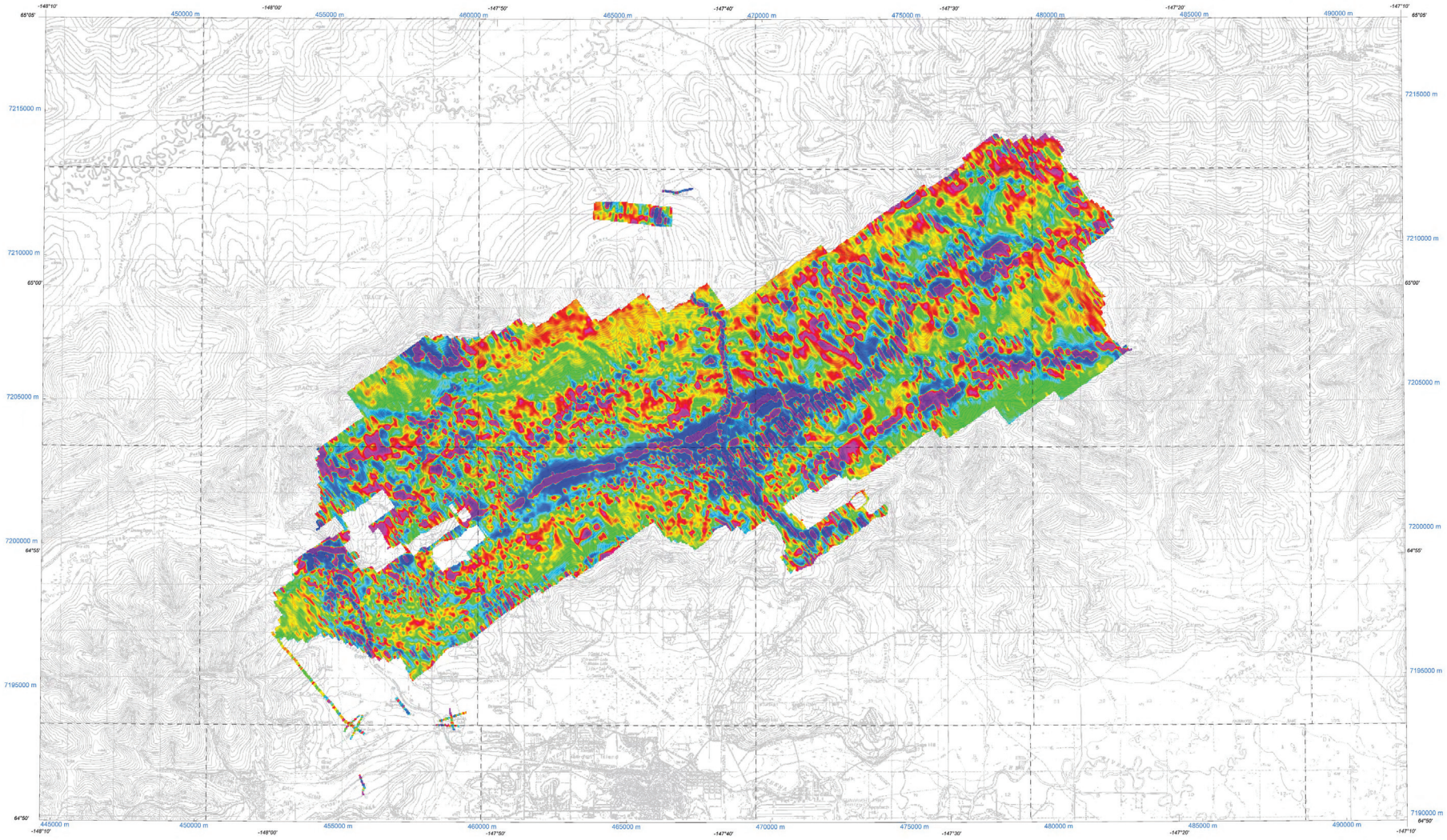
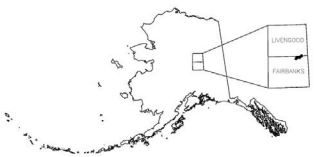


SURVEY LOCATION



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AIRBORNE ELECTROMAGNETIC AND MAGNETIC SURVEY GOLDSTREAM WATERSHED, INTERIOR ALASKA

http://doi.org/10.14509/29681

FIRST VERTICAL DERIVATIVE OF THE MAGNETIC FIELD WITH TOPOGRAPHY

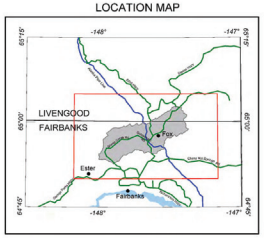
UNIVERSITY OF ALASKA FAIRBANKS

STATE OF ALASKA

NATIONAL SCIENCE FOUNDATION

Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, K., Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd.

LOCATION MAP



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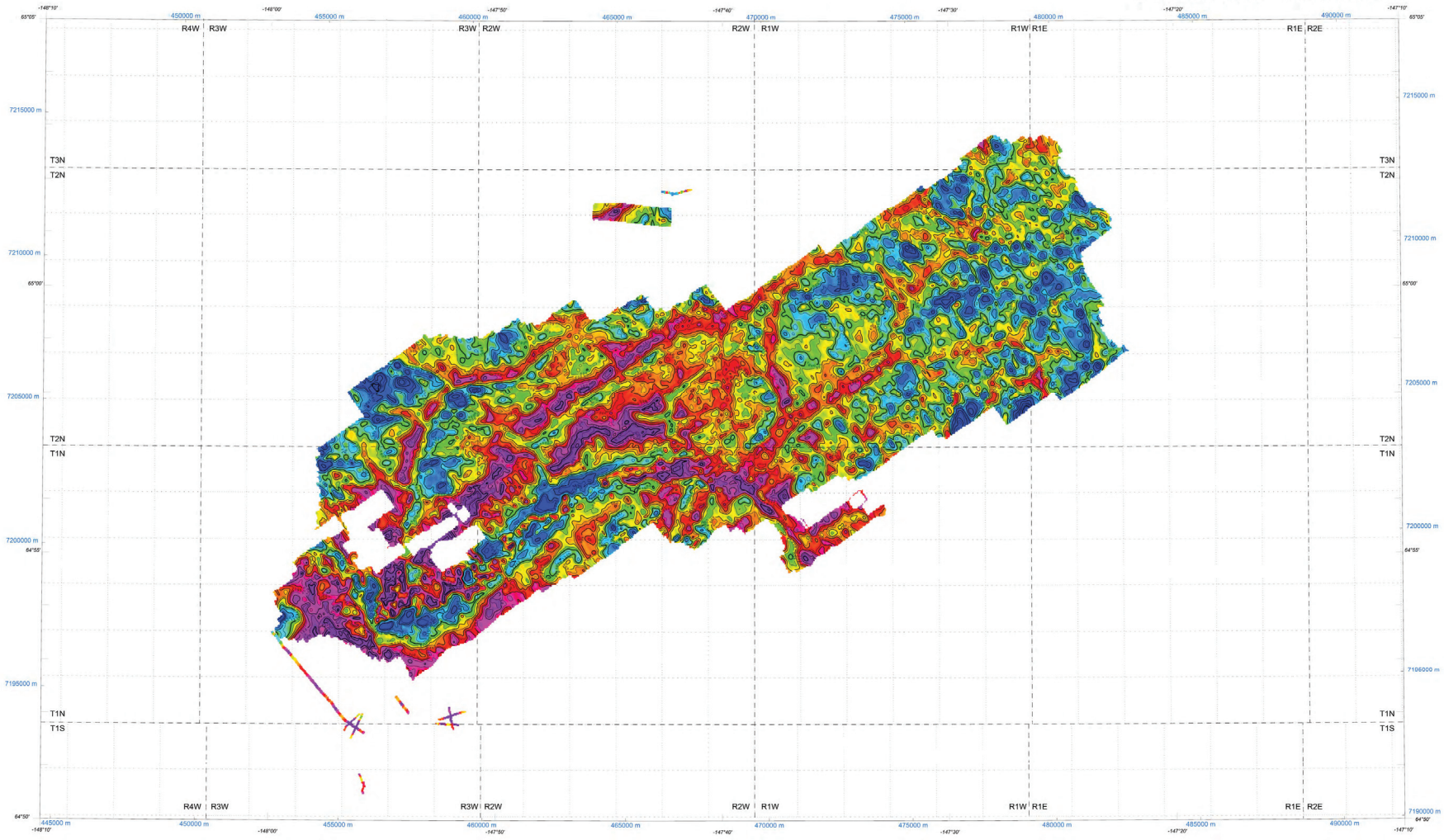
ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

GEOPHYSICAL REPORT 2016-5
140,000 Hz COPLANAR APPARENT RESISTIVITY GRID AND CONTOURS WITH TOWNSHIP, RANGE, AND SECTION; SCALE 1:63,360; SHEET 1 OF 1
QUADRANGLES: LIVENGOOD A-1, A-2, FAIRBANKS D-1, D-2



SURVEY LOCATION

DESCRIPTIVE NOTES

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RESISTIVITY

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RESISTIVITY ALTITUDE LIMITS

In areas where the EM bird height exceeded 150 m, resistivity was not calculated to avoid meaningless resistivity calculations for small signals where the helicopter flew higher to avoid cultural objects or for safety reasons. Blank areas in the grid were created where zones of high flying correlated over more than one survey line.

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AIRBORNE ELECTROMAGNETIC AND MAGNETIC SURVEY GOLDSTREAM WATERSHED, INTERIOR ALASKA

http://doi.org/10.14509/29681

APPARENT RESISTIVITY 140,000 Hz COPLANAR WITH CONTOURS

Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, K., Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd.

Scale 1:63,360

(miles) 1 0 1 2 3 4

(kilometers) 1 0 1 2 3 4 5

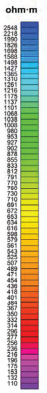
IRGS 84 / UTM zone 6N

Inclination: 71.5° N
Declination: 18.2° W
IGRF Model Year: 2015

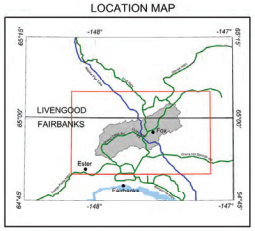
Resistivity Contours ohm-m

1000
800
600
500
400
300
250
200
150
125
100

10 intervals per decade



LOCATION MAP



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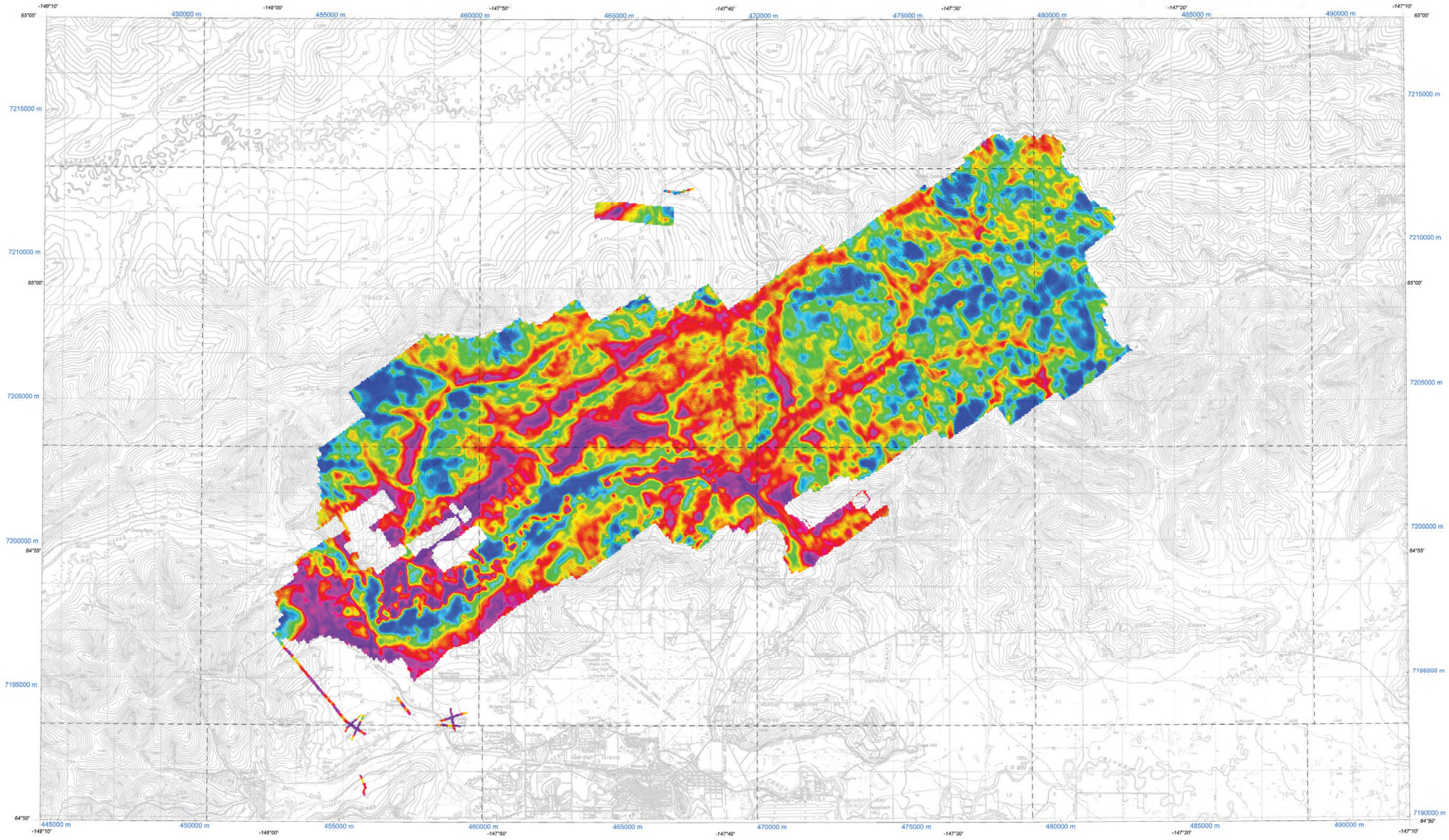
140,000 Hz COPLANAR APPARENT RESISTIVITY GRID WITH TOPOGRAPHY; SCALE 1:63,360; SHEET 1 OF 1
QUADRANGLES: LIVENGOOD A-1, A-2, FAIRBANKS D-1, D-2



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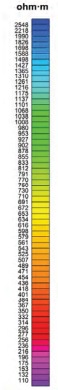
Scale 1:63,360

(miles) 1 0 1 2 3 4

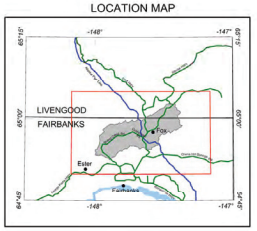
(kilometers) 1 0 1 2 3 4 5

WGS 84 / UTM zone 6N

Inclination: / / 6° N
Declination: 18.2° W
IGRF Model Year: 2015



LOCATION MAP



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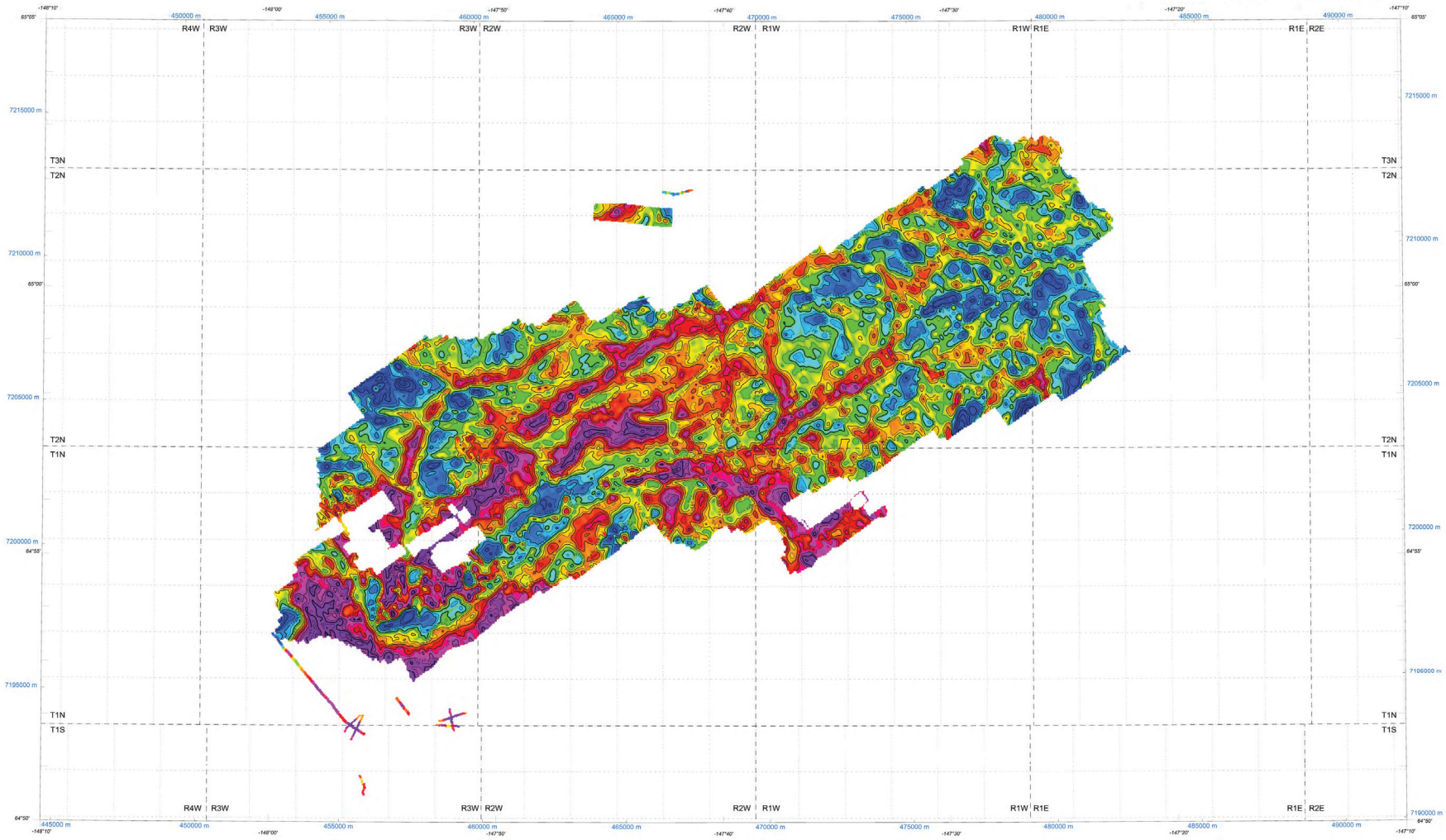

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http://doi.org/10.14509/29681

APPARENT RESISTIVITY 40,000 Hz COPLANAR WITH CONTOURS

UNIVERSITY OF ALASKA FAIRBANKS

STATE OF ALASKA

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Scale 1:63,360

(miles) 1 0 1 2 3 4

(kilometers) 1 0 1 2 3 4 5

NAD 83 / UTM zone 6N

Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, K., Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd.

TRUE NORTH

MAGNETIC NORTH

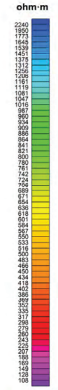
Inclination: / / 8° N
Declination: 18.2° W
IGRF Model Year: 2015

Resistivity Contours ohm-m

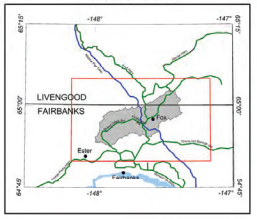
1000
800
600
500
400
300
250
200
150
125
100

10 intervals per decade

ohm·m



LOCATION MAP



SURVEY HISTORY

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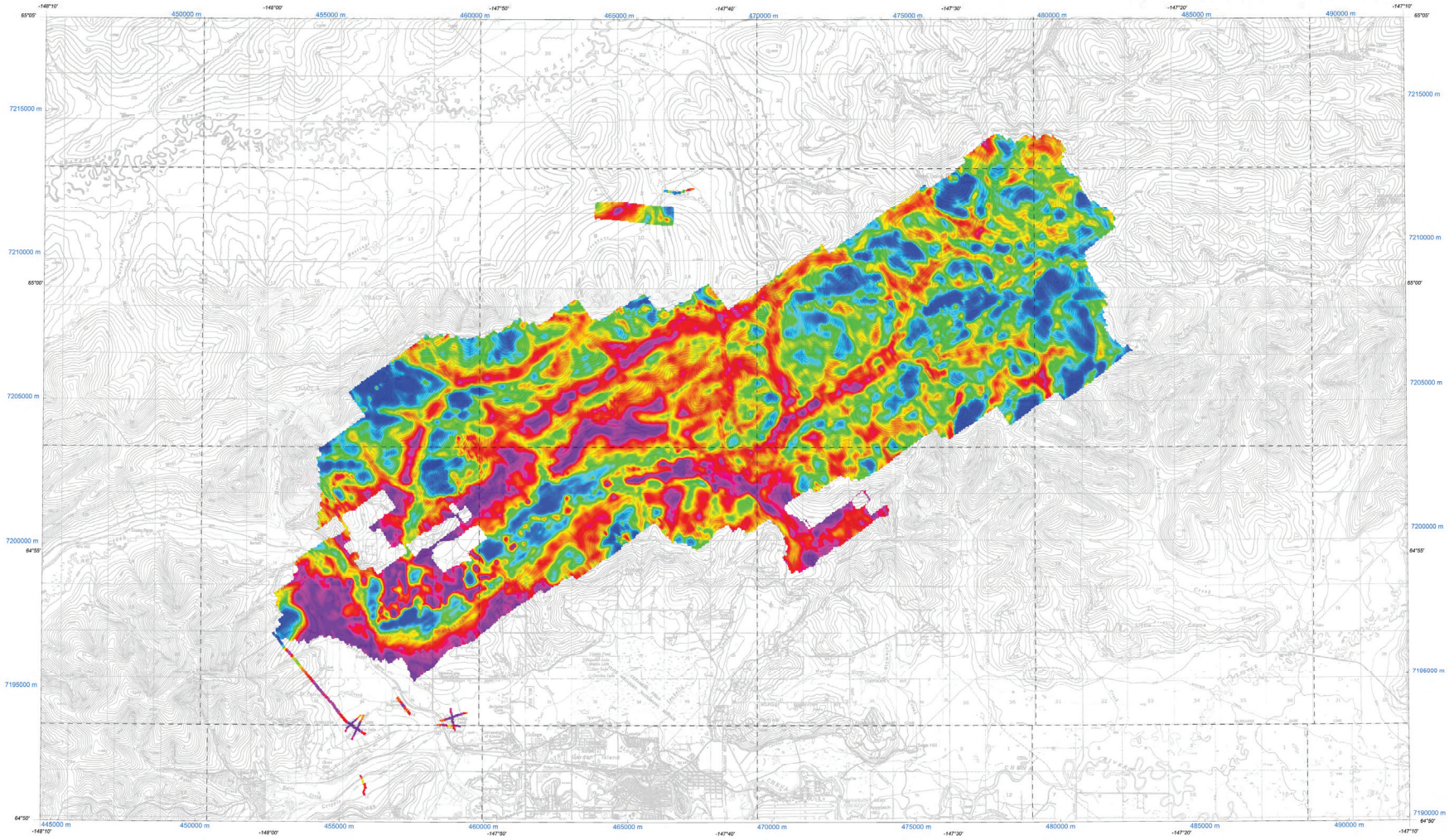
ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

GEOPHYSICAL REPORT 2016-5
40,000 Hz COPLANAR APPARENT RESISTIVITY GRID WITH TOPOGRAPHY; SCALE 1:63,360; SHEET 1 OF 1
QUADRANGLES: LIVENGOOD A-1, A-2, FAIRBANKS D-1, D-2



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POWER LINE INTERFERENCE

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AIRBORNE ELECTROMAGNETIC AND MAGNETIC SURVEY GOLDSTREAM WATERSHED, INTERIOR ALASKA

http://doi.org/10.14509/29681

APPARENT RESISTIVITY 40,000 Hz COPLANAR WITH TOPOGRAPHY

UNIVERSITY OF ALASKA FAIRBANKS

STATE OF ALASKA

NATIONAL SCIENCE FOUNDATION

Scale 1:63,360

1 0 1 2 3 4
(miles)

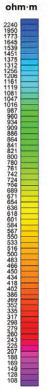
1 0 1 2 3 4 5
(kilometers)
WGS 84 / UTM zone 6N

TRUE NORTH
MAGNETIC NORTH

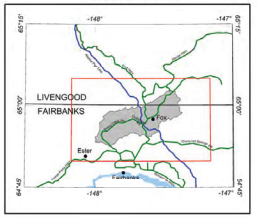
Inclination: / / 6° N
Declination: 18.2° W
IGRF Model Year: 2015

Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, K., Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd.

ohm·m



LOCATION MAP



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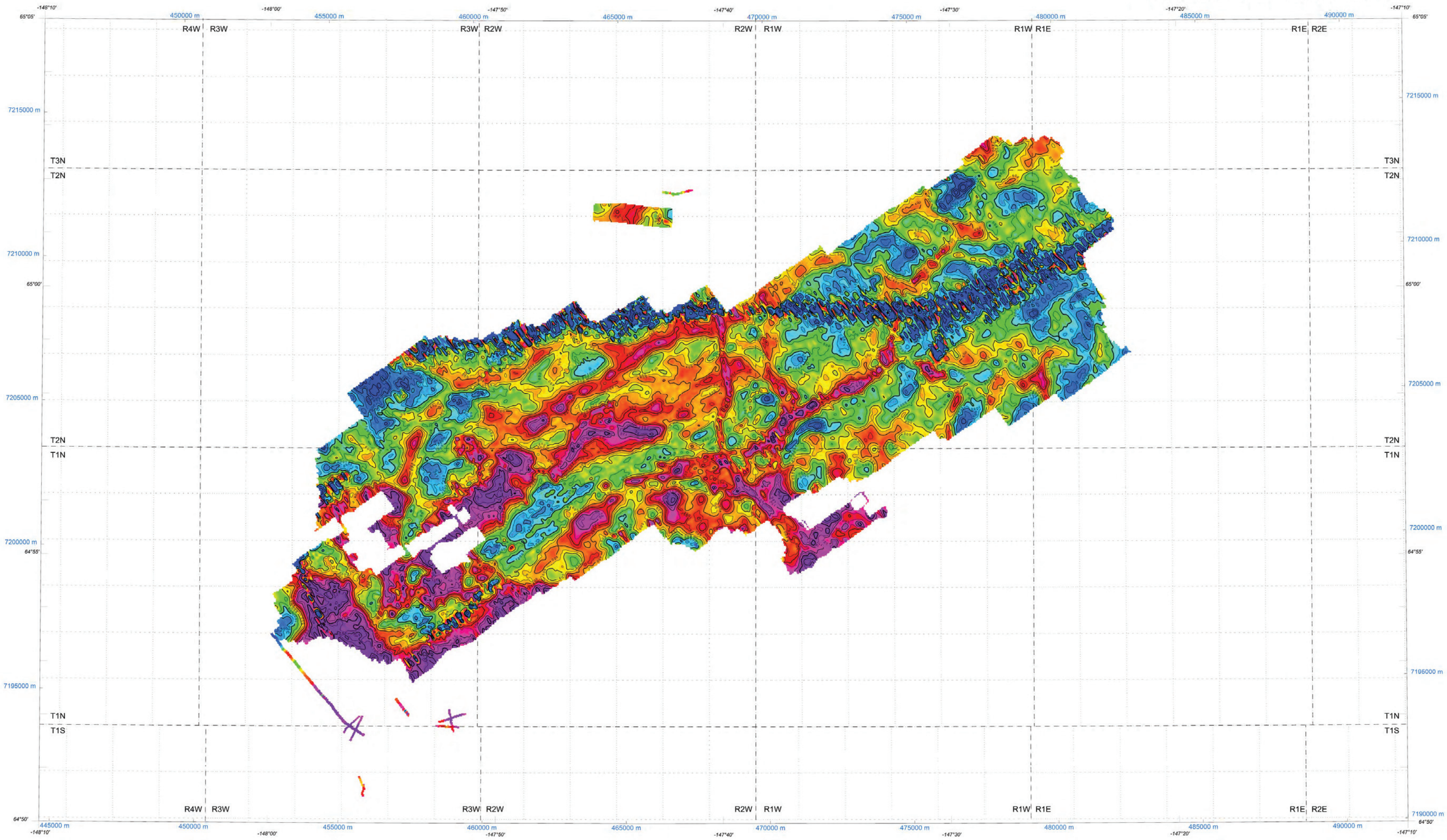
ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

GEOPHYSICAL REPORT 2016-5
8,200 Hz COPLANAR APPARENT RESISTIVITY GRID AND CONTOURS WITH TOWNSHIP, RANGE, AND SECTION; SCALE 1:63,360; SHEET 1 OF 1
QUADRANGLES: LIVENGOOD A-1, A-2, FAIRBANKS D-1, D-2



AIRBORNE ELECTROMAGNETIC AND MAGNETIC SURVEY GOLDSTREAM WATERSHED, INTERIOR ALASKA

http://doi.org/10.14509/29681

APPARENT RESISTIVITY 8,200 Hz COPLANAR WITH CONTOURS

Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, K., Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd.

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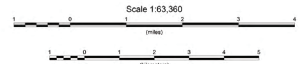
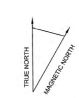




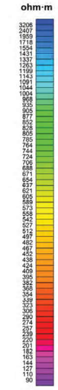
Inclination: 77.6° N
Declination: 18.2° W
IGRF Model Year: 2015

Resistivity Contours ohm-m

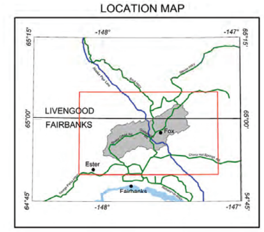
1000
800
600
500
400
300
250
200
150
125
100

10 intervals per decade

ohm·m



LOCATION MAP



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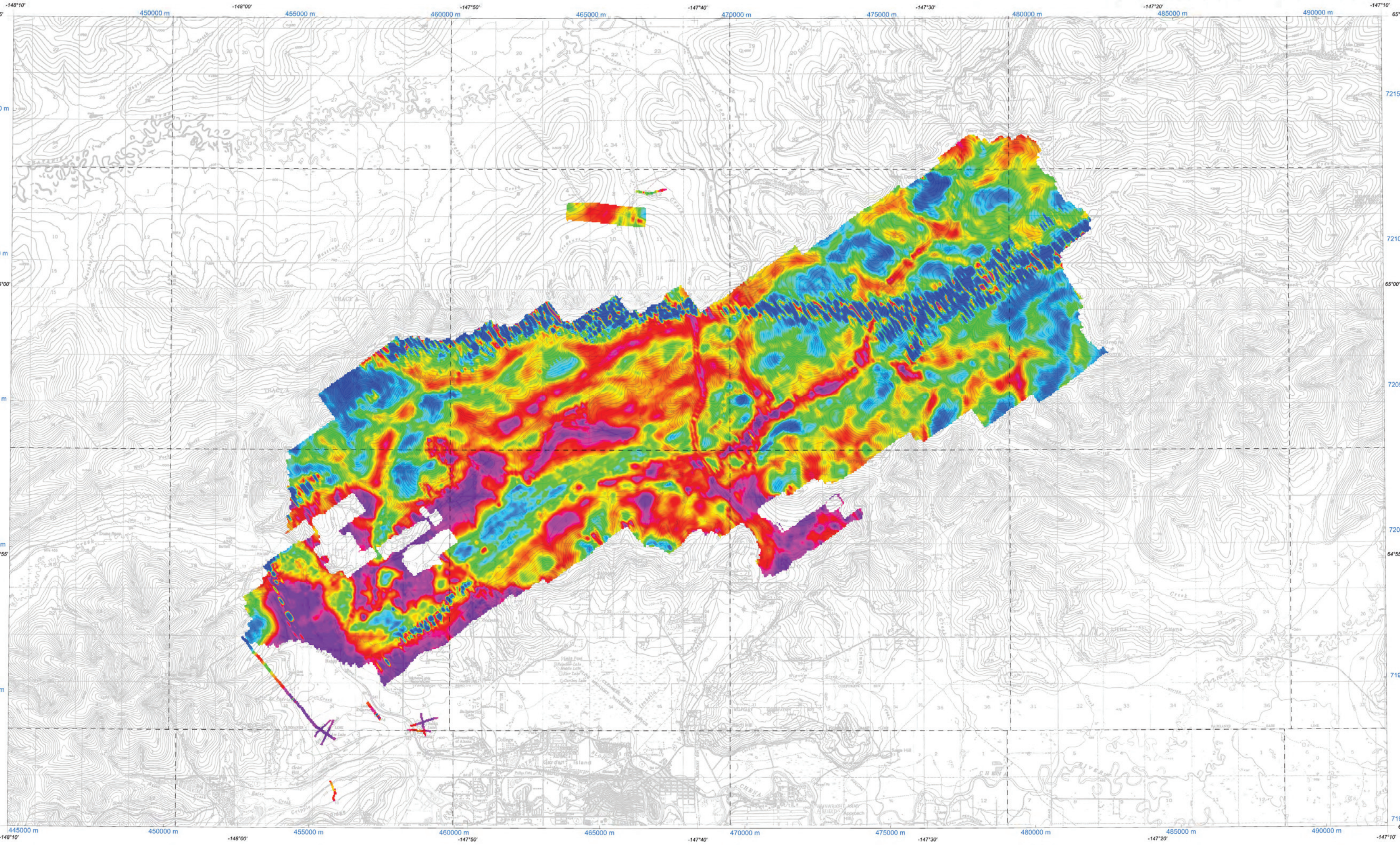


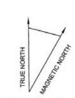
AIRBORNE ELECTROMAGNETIC AND MAGNETIC SURVEY GOLDSTREAM WATERSHED, INTERIOR ALASKA

http://doi.org/10.14509/29681

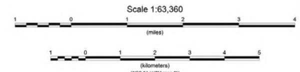
APPARENT RESISTIVITY 8,200 Hz COPLANAR WITH TOPOGRAPHY

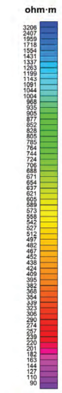
Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, K., Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd.

SURVEY LOCATION

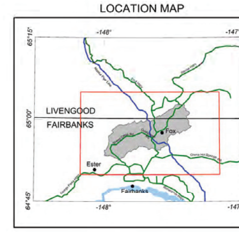


Inclination: 77.6° N
Declination: 18.2° W
IGRF Model Year: 2015





LOCATION MAP



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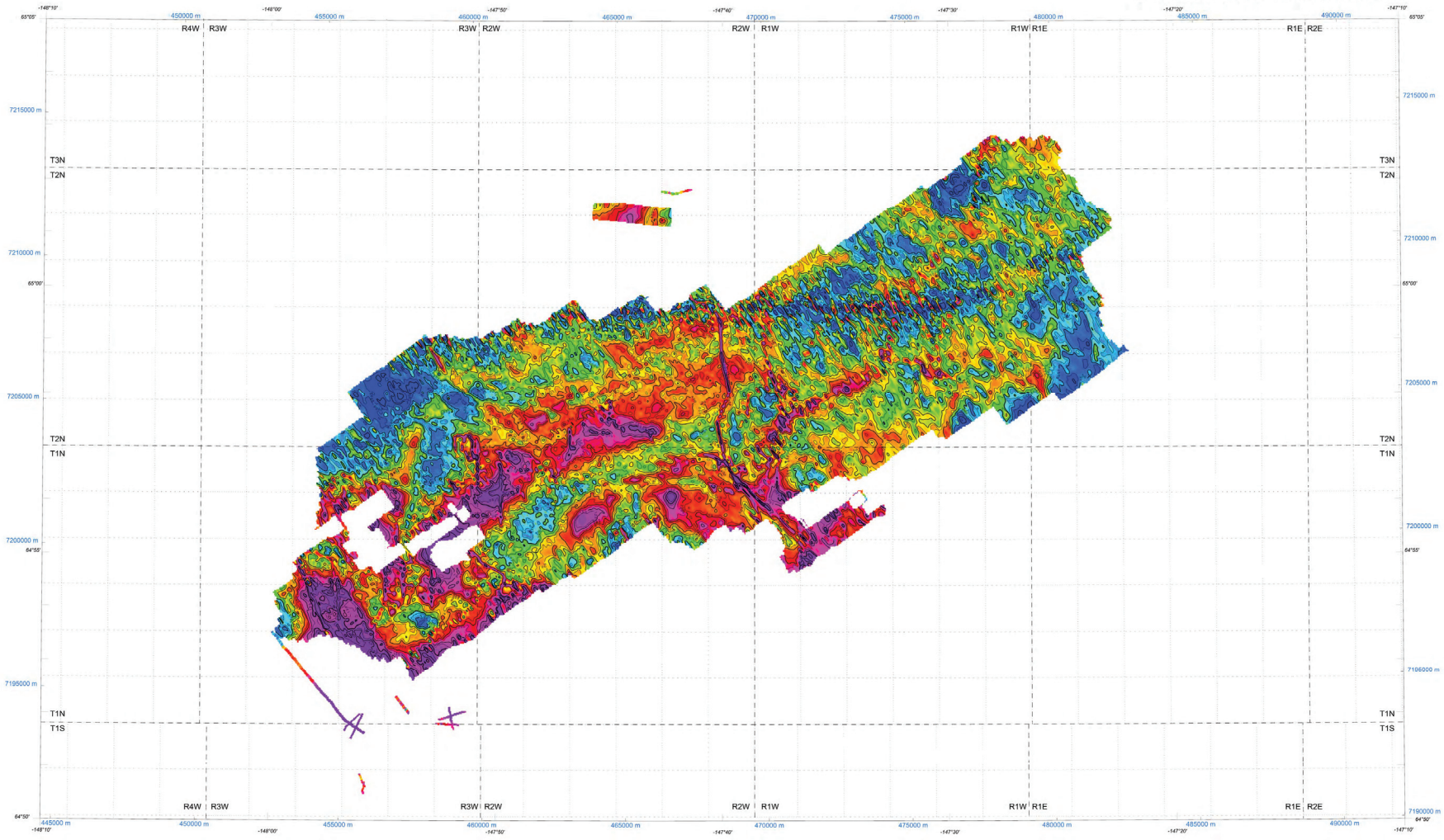
ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

GEOPHYSICAL REPORT 2016-5
3,300 Hz COAXIAL APPARENT RESISTIVITY GRID AND CONTOURS WITH TOWNSHIP, RANGE, AND SECTION; SCALE 1:63,360; SHEET 1 OF 1
QUADRANGLES: LIVENGOOD A-1, A-2, FAIRBANKS D-1, D-2



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http://doi.org/10.14509/29681

APPARENT RESISTIVITY 3,300 Hz COAXIAL WITH CONTOURS

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Scale 1:63,360

(miles) 1 0 1 2 3 4

(kilometers) 1 0 1 2 3 4 5

IRGS 84 / UTM zone 6N

Inclination: / / 6° N
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Resistivity Contours ohm-m

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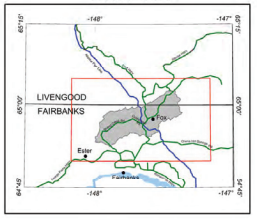
10 intervals per decade

LOCATION MAP



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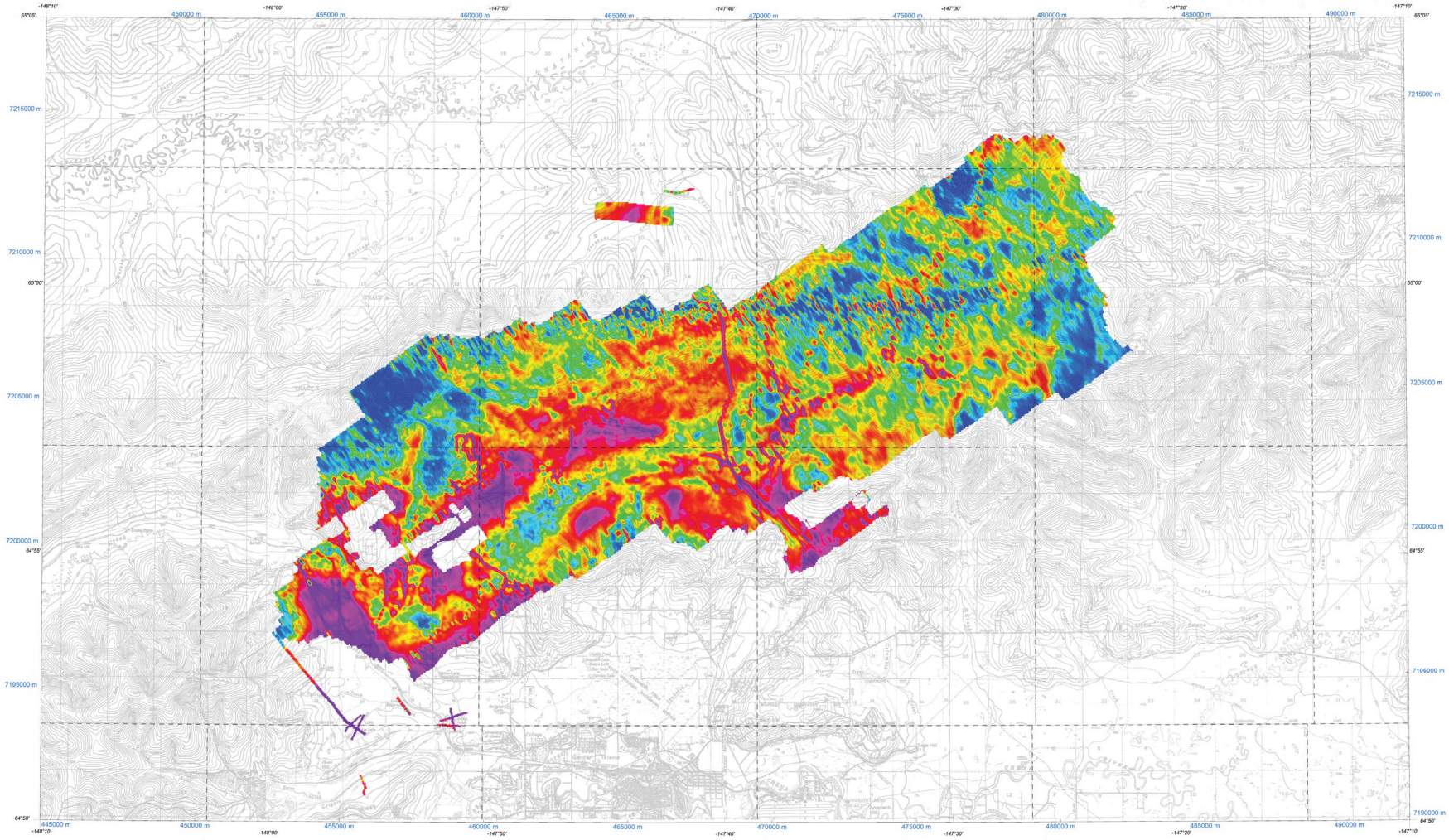

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AIRBORNE ELECTROMAGNETIC AND MAGNETIC SURVEY GOLDSTREAM WATERSHED, INTERIOR ALASKA

http://doi.org/10.14509/29681

APPARENT RESISTIVITY 3,300 Hz COAXIAL WITH TOPOGRAPHY

UNIVERSITY OF ALASKA FAIRBANKS

STATE OF ALASKA

NATIONAL SCIENCE FOUNDATION

Scale 1:63,360

(miles) 1 0 1 2 3 4

(kilometers) 1 0 1 2 3 4 5

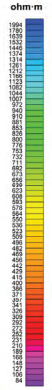
NAD 83 / UTM zone 6N

TRUE NORTH

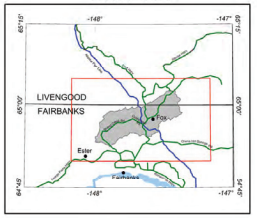
MAGNETIC NORTH

Inclination: / / 6° N
Declination: 18.2° W
IGRF Model Year: 2015

ohm·m



LOCATION MAP



Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, K., Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd.

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*National Science Foundation, Office of Polar Programs, Arctic System Science Program, Award #1500931

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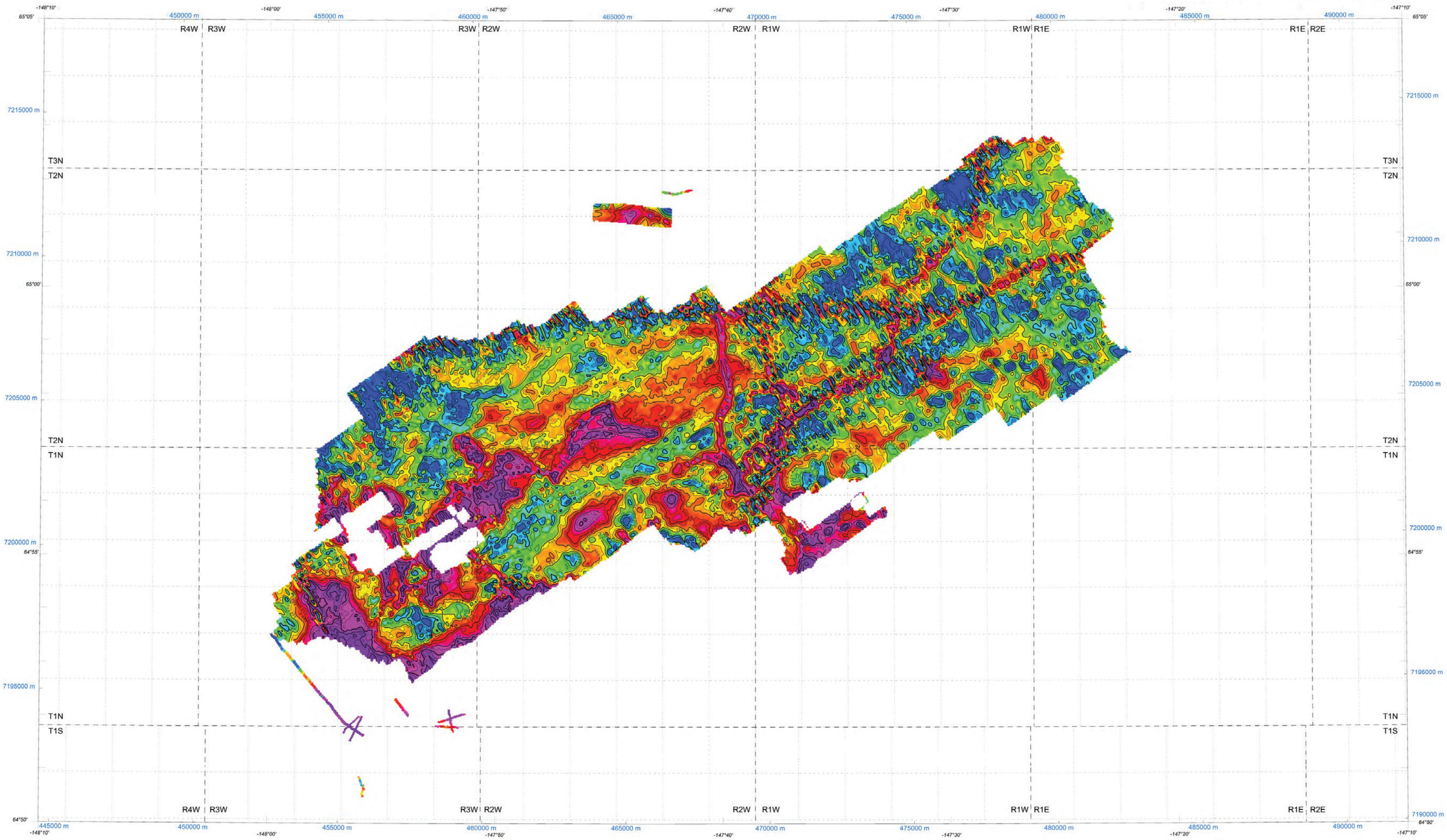


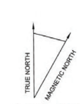
AIRBORNE ELECTROMAGNETIC AND MAGNETIC SURVEY GOLDSTREAM WATERSHED, INTERIOR ALASKA

http://doi.org/10.14509/29681

APPARENT RESISTIVITY 1,800 Hz COPLANAR WITH CONTOURS

Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, K., Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd.

SURVEY LOCATION



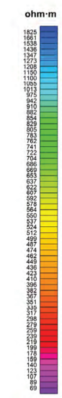
Inclination: 77.6° N
Declination: 18.2° W
IGRF Model Year: 2015

Scale 1:63,360

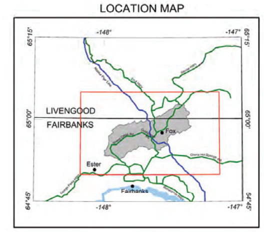
Resistivity Contours ohm-m

1000
800
600
500
400
300
250
200
150
125
100

10 intervals per decade



LOCATION MAP



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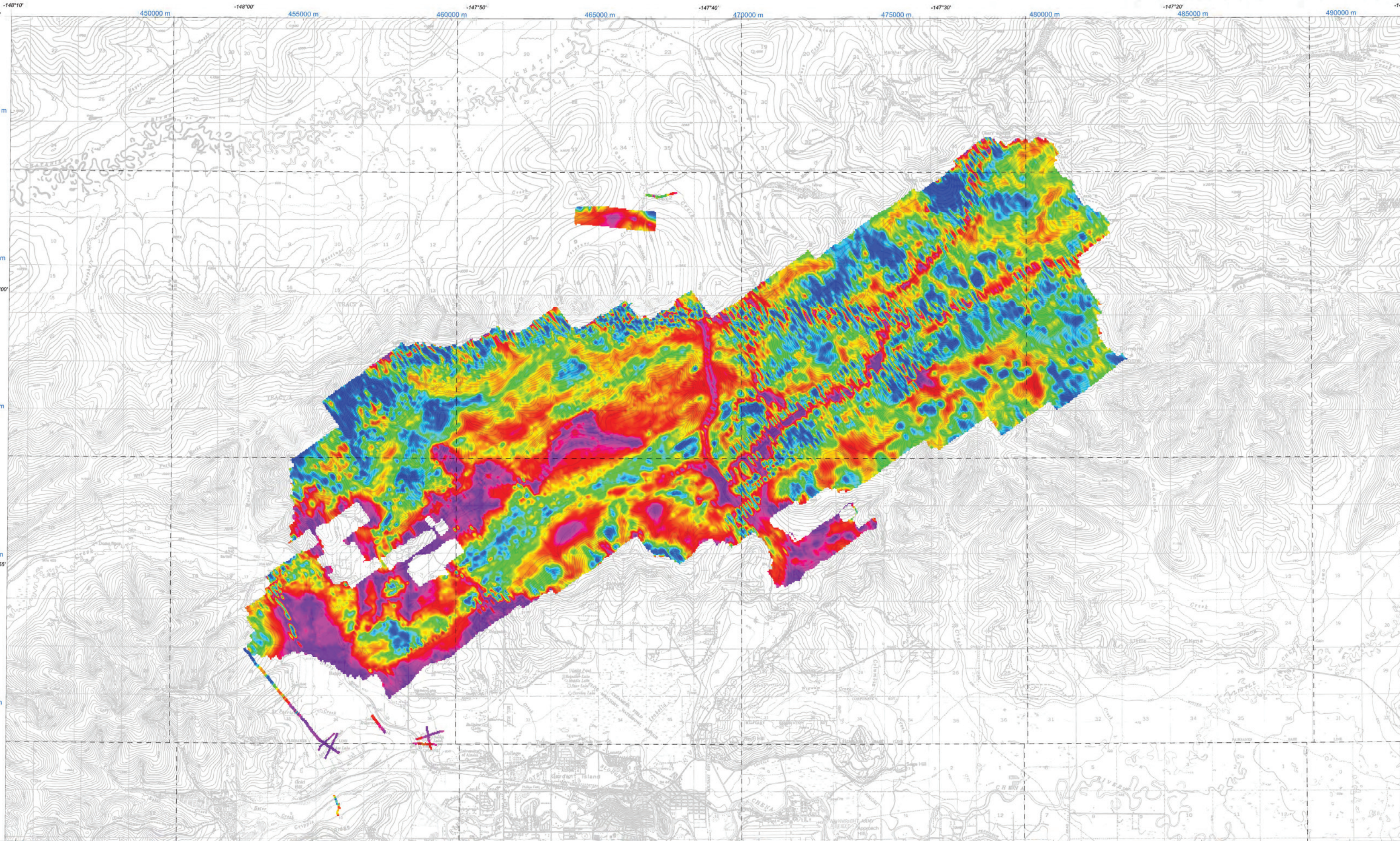

AIRBORNE ELECTROMAGNETIC AND MAGNETIC SURVEY GOLDSTREAM WATERSHED, INTERIOR ALASKA

http://doi.org/10.14509/29681

APPARENT RESISTIVITY 1,800 Hz COPLANAR WITH TOPOGRAPHY

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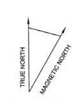
SURVEY LOCATION

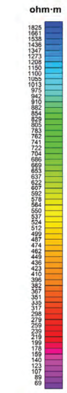


Inclination: 77.6° N
Declination: 18.2° W
IGRF Model Year: 2015

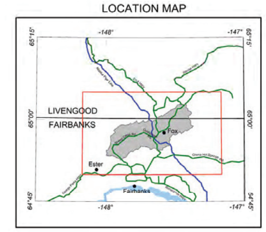
Scale 1:63,360

(miles)

(kilometers)



LOCATION MAP



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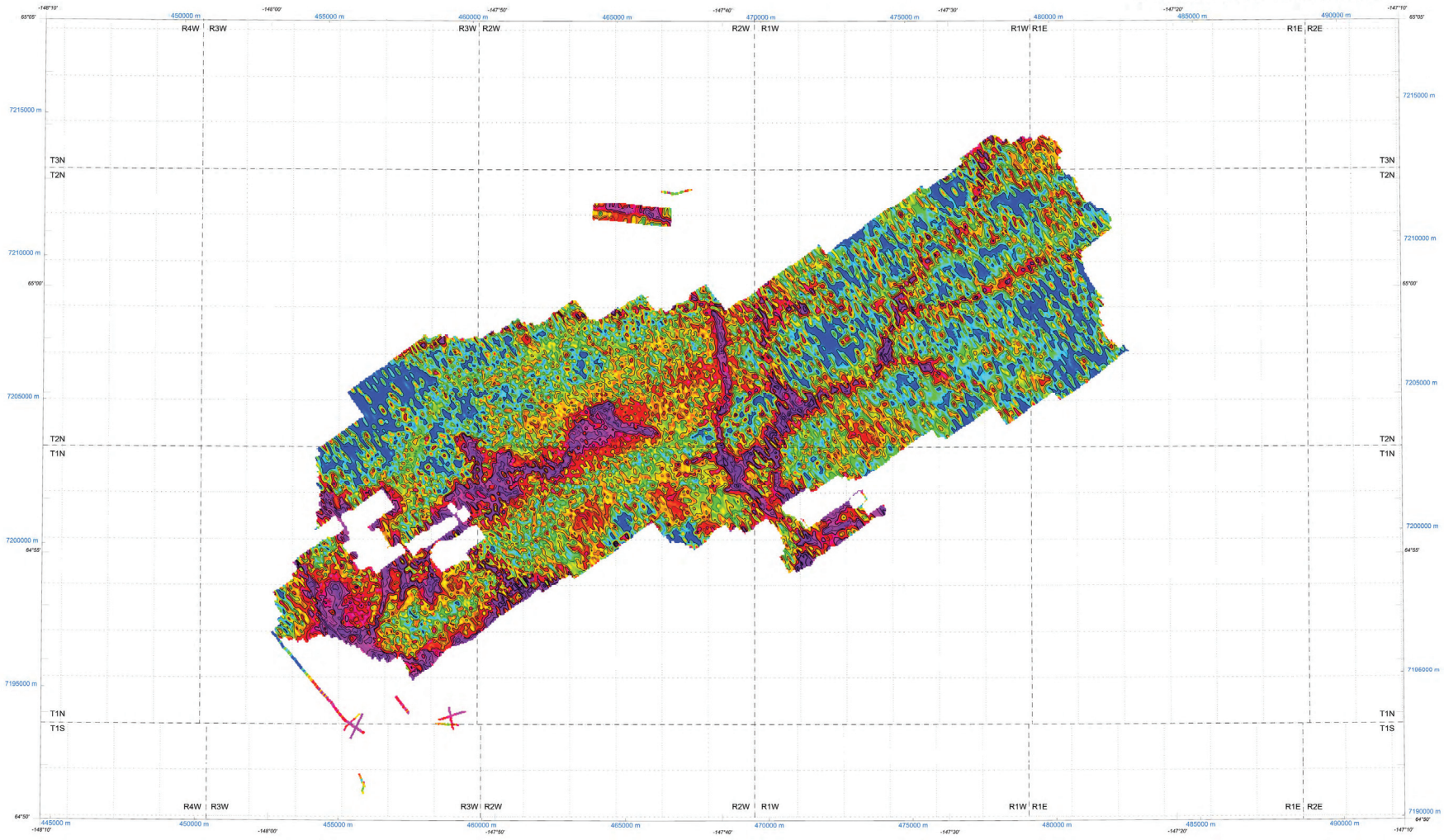
ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

GEOPHYSICAL REPORT 2016-5
400 Hz COPLANAR APPARENT RESISTIVITY GRID AND CONTOURS WITH TOWNSHIP, RANGE, AND SECTION; SCALE 1:63,360; SHEET 1 OF 1
QUADRANGLES: LIVENGOOD A-1, A-2, FAIRBANKS D-1, D-2



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APPARENT RESISTIVITY 400 Hz COPLANAR WITH CONTOURS

UNIVERSITY OF ALASKA FAIRBANKS

STATE OF ALASKA

NATIONAL SCIENCE FOUNDATION

Scale 1:63,360

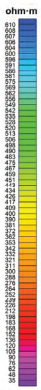
1 0 1 2 3 4
(miles)

1 0 1 2 3 4 5
(kilometers)
IRGS 84 / UTM zone 6N

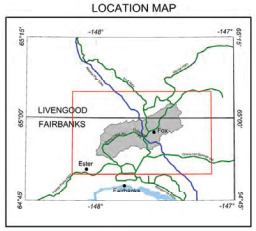
Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, K., Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd.

Inclination: / / 8.° N
Declination: 18.2° W
IGRF Model Year: 2015

Resistivity Contours ohm-m
1000
800
600
500
400
300
250
200
150
125
100
10 intervals per decade



LOCATION MAP



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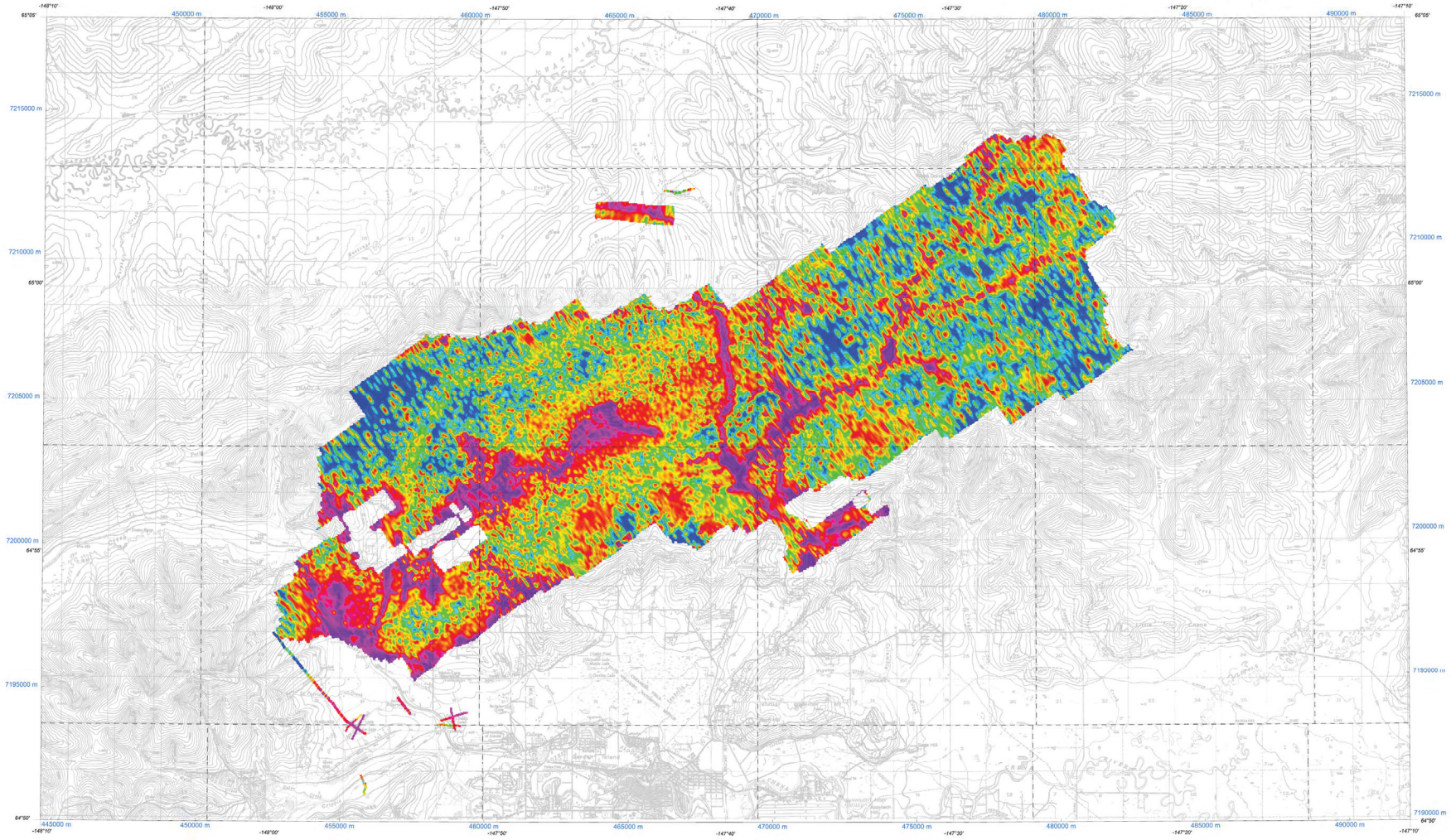

SURVEY LOCATION

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http://doi.org/10.14509/29681

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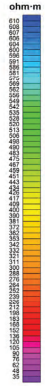
Scale 1:63,360

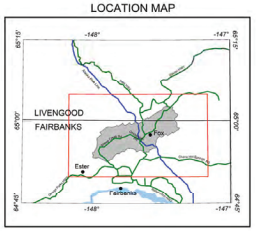
(miles) 0 1 2 3 4

(kilometers) 0 1 2 3 4 5

WGS 84 / UTM zone 6N



LOCATION MAP



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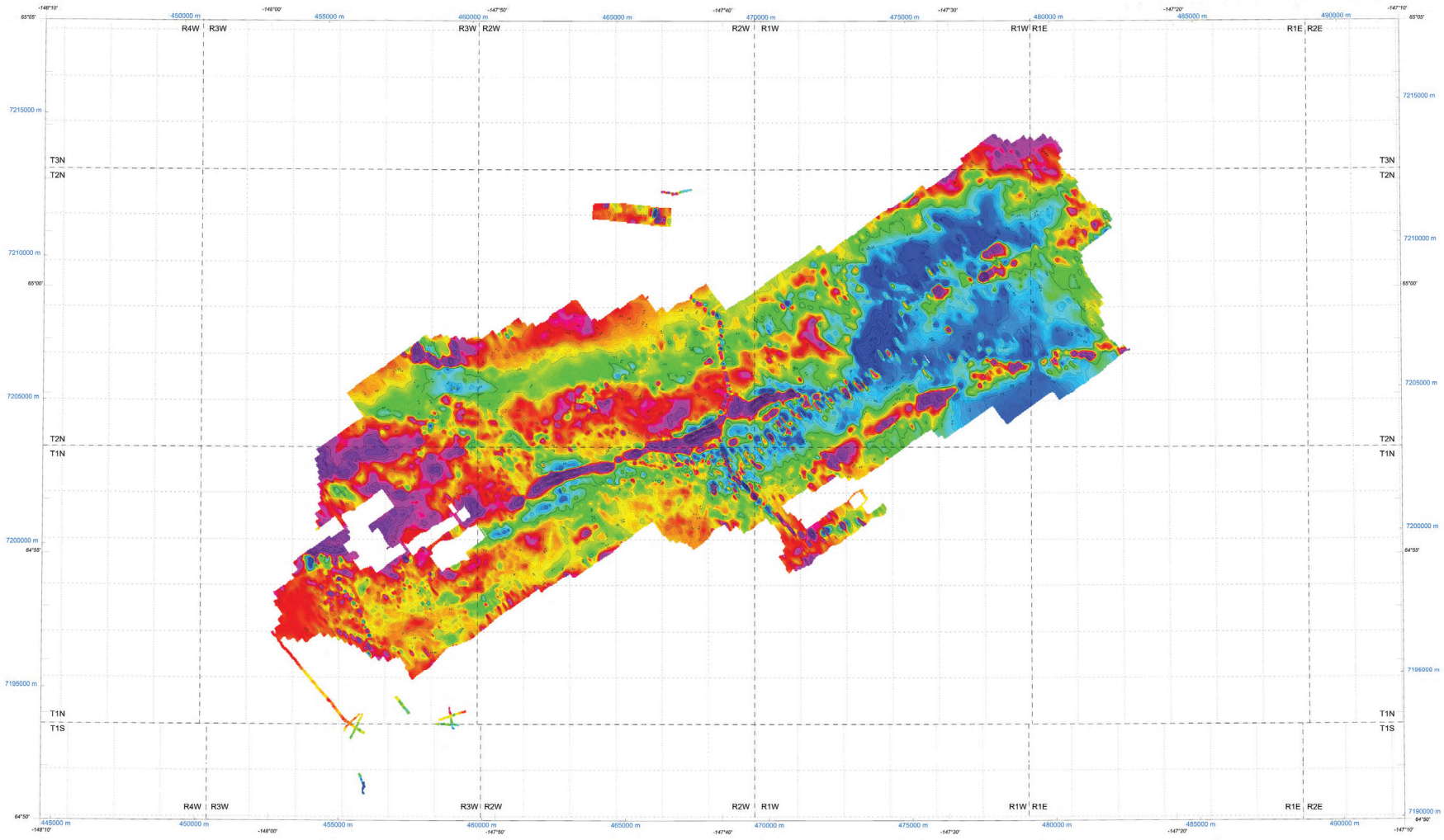

SURVEY LOCATION

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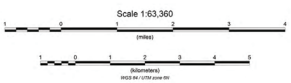
http://doi.org/10.14509/29681

RESIDUAL MAGNETIC INTENSITY WITH CONTOURS

Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, K., Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd.

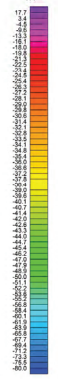
Inclination: / / 8.° N
Declination: 18.2° W
IGRF Model Year: 2015

Scale 1:63,360

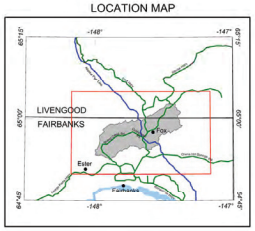


RMI Contour Interval nT

	1
	2
	10
	50



LOCATION MAP



DESCRIPTIVE NOTES

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Traverse lines were flown approximately northeast/southwest (055°/235°) at a line spacing of 200 m for the main block and infill lines were flown in two blocks for a final line spacing of 100 m in these areas. Tie lines were flown northwest/southeast (145°/325°) with variable line spacing.

Lines were flown over Ace/Deuce Lakes, Smith Lake, Methane Well, and Vault Lake. Although not part of the main gridded area, these data are presented as sindle line cnds to show their location.

RESIDUAL MAGNETIC INTENSITY

The magnetic total field data were processed using digitally recorded data from a CGG D1344 base station magnetometer with a Scintrex CS3 cesium sensor. Data were collected at a sampling interval of 0.1 seconds. The magnetic data were (1) corrected for diurnal variations by subtraction of the base station magnetic data, (2) IGRF corrected (IGRF model 2015, updated for data of flight and altimeter variations), and (3) leveled using the tie line data.

POWER LINE INTERFERENCE

Power transmission lines affect the EM data to varying degrees dependent on the EM frequency and the power line itself. Many power lines are present within the Goldstream survey block. Whereas most affect the EM data only in close proximity to the power line, severe interference is evident over a wider corridor across some power lines. This is especially evident in the 1800 Hz and 8200 Hz resistivity parameters along a transmission line that extends approximately east/west across the northern edge of the survey block.

SURVEY HISTORY

This map has been compiled and drawn under contract between the State of Alaska, Department of Natural Resources, Division of Geological & Geophysical Surveys (DGGS) and CGG Canada Services Ltd.

The survey was funded by the National Science Foundation* (NSF) as part of the Goldstream Valley Watershed Project with the University of Alaska Fairbanks Institute of Northern Engineering (INE) Water and Environmental Research Center (WERC).

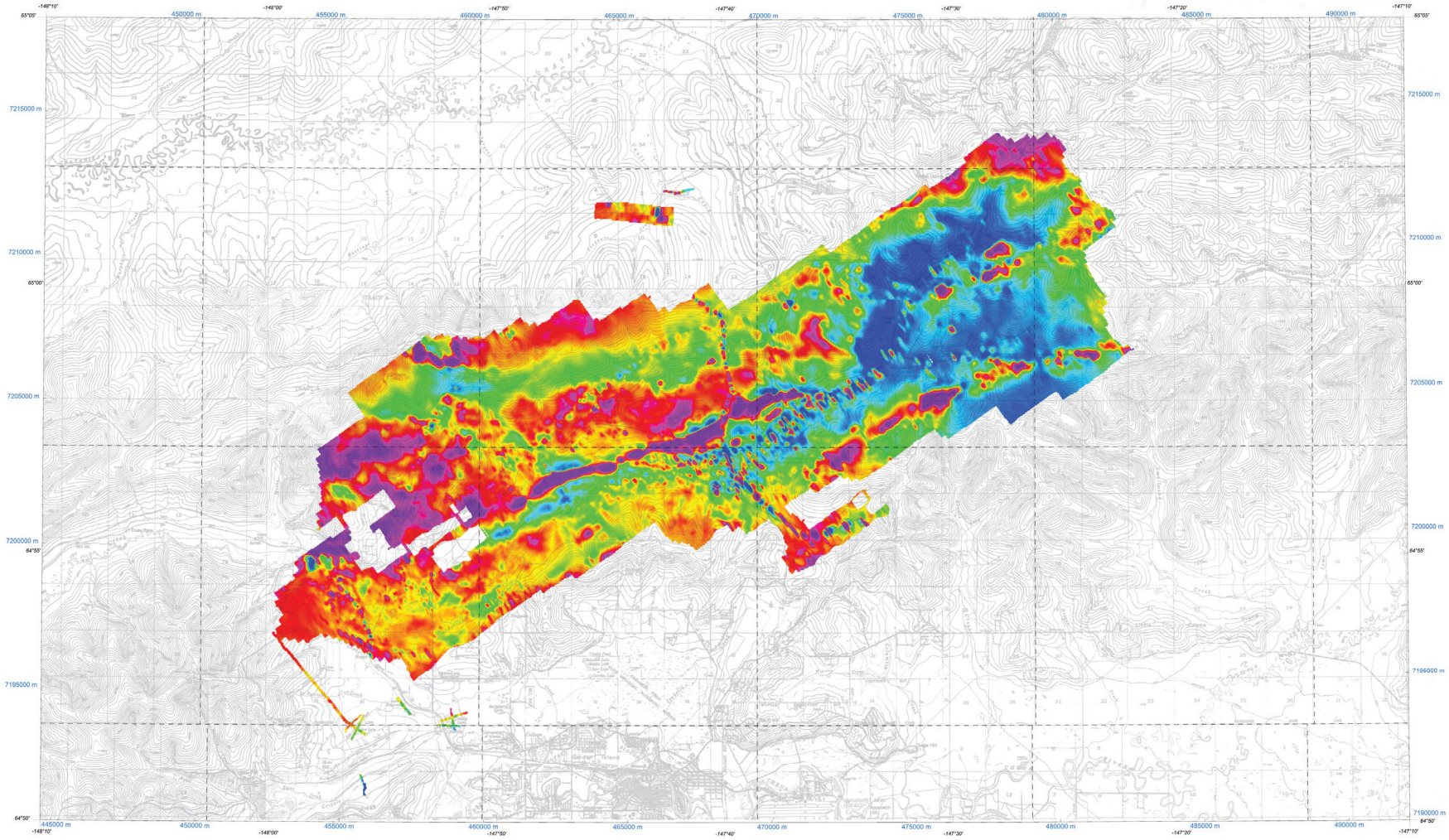
*National Science Foundation, Office of Polar Programs, Arctic System Science Program, Award #1500931

DGGS acknowledges technical support provided by scientists from the University of Alaska Fairbanks and by scientists from the U.S. Geological Survey Crustal Geophysics and Geochemistry Science Center, Denver, Colorado.

All data and maps produced from this survey are available for download from the DGGS website (http://dggs.alaska.gov). Digital products and paper maps are also available from the DGGS office, 3354 College Road, Fairbanks, Alaska, 99709-3707 (phone 907-451-5010; email: dggspubs@alaska.gov).

ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

GEOPHYSICAL REPORT 2016-5
RESIDUAL MAGNETIC INTENSITY GRID WITH TOPOGRAPHY; SCALE 1:63,360; SHEET 1 OF 1
QUADRANGLES: LIVENGOOD A-1, A-2, FAIRBANKS D-1, D-2



SURVEY LOCATION

AIRBORNE ELECTROMAGNETIC AND MAGNETIC SURVEY GOLDSTREAM WATERSHED, INTERIOR ALASKA

http://doi.org/10.14509/29681

RESIDUAL MAGNETIC INTENSITY WITH TOPOGRAPHY

Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, K., Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd.

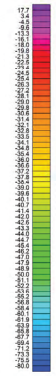
Inclination: / / 6° N
Declination: 18.2° W
IGRF Model Year: 2015

Scale 1:63,360

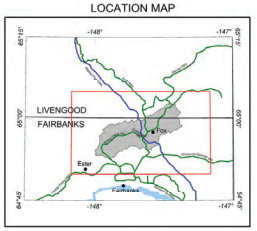
(miles)

(kilometers)

NAD 84 / UTM zone 6N



LOCATION MAP



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