ELECTROMAGNETIC AND MAGNETIC AIRBORNE-GEOPHYSICAL SURVEY OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, ALASKA (DATA COMPILATION): SURVEY OVERVIEW

Fugro Airborne Surveys Corp., Stevens Exploration Management Corp.,
Laurel E. Burns, and Gina R.C. Graham

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DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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Fugro Airborne Surveys Corp., Stevens Exploration Management Corp., Laurel E. Burns[1], and Gina R.C. Graham[1]

ABSTRACT

The Liberty Bell geophysical survey was originally flown in 2001 and published in 2002 (Alaska Division of Geological & Geophysical Surveys and others, 2002) as a part of the State of Alaska's Airborne Geophysical/Geological Mineral Inventory (AGGMI) program. This publication supersedes the previous publications to provide a compilation of published and unpublished information and includes standardized databases and product formats, upgrades digital datasets to modern formats, and re-releases the historical survey and associated documentation (http://doi.org/10.14509/29690). This publication contains geophysical data produced from airborne surveys flown from the 24th to 27th of August 2001 for 2,023.6 line kilometers at 400m line spacing in the Bonnifield mining district, Alaska. This DIGHEMV electromagnetic/magnetic survey was flown by Fugro Airborne Surveys Corp. under contract to Stevens Exploration Management Corp.

PURPOSE

The Liberty Bell airborne magnetic and electromagnetic survey, located in the northern foothills of the Alaska Range of central Interior Alaska, covers part of the Bonnifield mining district, which contains known intrusion-related and placer gold deposits and occurrences. It is also prospective for porphyry copper ± gold ± molybdenum ± silver, skarn, volcanogenic massive sulfide, and other deposit types. The survey is part of the AGGMI program to acquire data on Alaska's most promising mineral belts and districts aimed at catalyzing private sector exploration.

SURVEY OVERVIEW DESCRIPTION

This booklet provides a visual overview of available digital processed magnetic and electromagnetic datasets for the Liberty Bell geophysical survey (figs. 3–9). Each figure is accompanied by a brief summary of the data type, and associated data-recording instrumentation, sampling rate, and processing steps. All detailed survey specifications and data processing steps can be found in the associated metadata and readme files, as well as in the Liberty Bell project report. A catalog overviewing paper- and printable-format map sheets can be found in Table 1.

[1] Alaska Division of Geological & Geophysical Surveys, 3354 College Road, Fairbanks, Alaska 99709-3707

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	contractor	Geographically registered gridded data, ER Mapper ERS format
grids_geosoft	contractor	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	contractor	kml language kmz archive files of project data
maps_pdf_format	contractor	Printable maps in pdf format
maps_prn_format	contractor	Printable maps in HPGL/G printer file format with extension .prn
profiles_stacked_pdf	contractor	Electromagnetic and magnetic data profiles with EM anomalies, files in PDF format
profiles_stacked_prn	contractor	Electromagnetic and magnetic data profiles with EM anomalies, files in PRN format
vector_data	contractor	Line path, data contours, and survey boundary in ESRI shape file (SHP) format
video_flightpath	contractor	Survey flight path downward facing video

ACKNOWLEDGMENTS

This project was funded by the State of Alaska's Airborne Geophysical/Geological Mineral Inventory (AGGMI) program.

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Burns, L.E., Fugro Airborne Surveys Corp., Stevens Exploration Management Corp., Graham, G.R.C., and Emond, A.M., 2016, Bonnifield mining district electromagnetic and magnetic airborne geophysical survey data compilation: Alaska Division of Geological & Geophysical Surveys Geophysical Report 2016-1, 2 sheets. http://doi.org/10.14509/29557

Geoterrex-Dighem, Fugro Airborne Surveys, Stevens Exploration Management Corp., Pritchard, R.A., Burns, L.E., Emond, A.M., and DGGS Staff, 2016, Sub-regional, merged, gridded airborne geophysical data: Alaska Division of Geological & Geophysical Surveys Digital Data Series 12, 1 DVD. http://doi.org/10.14509/29555

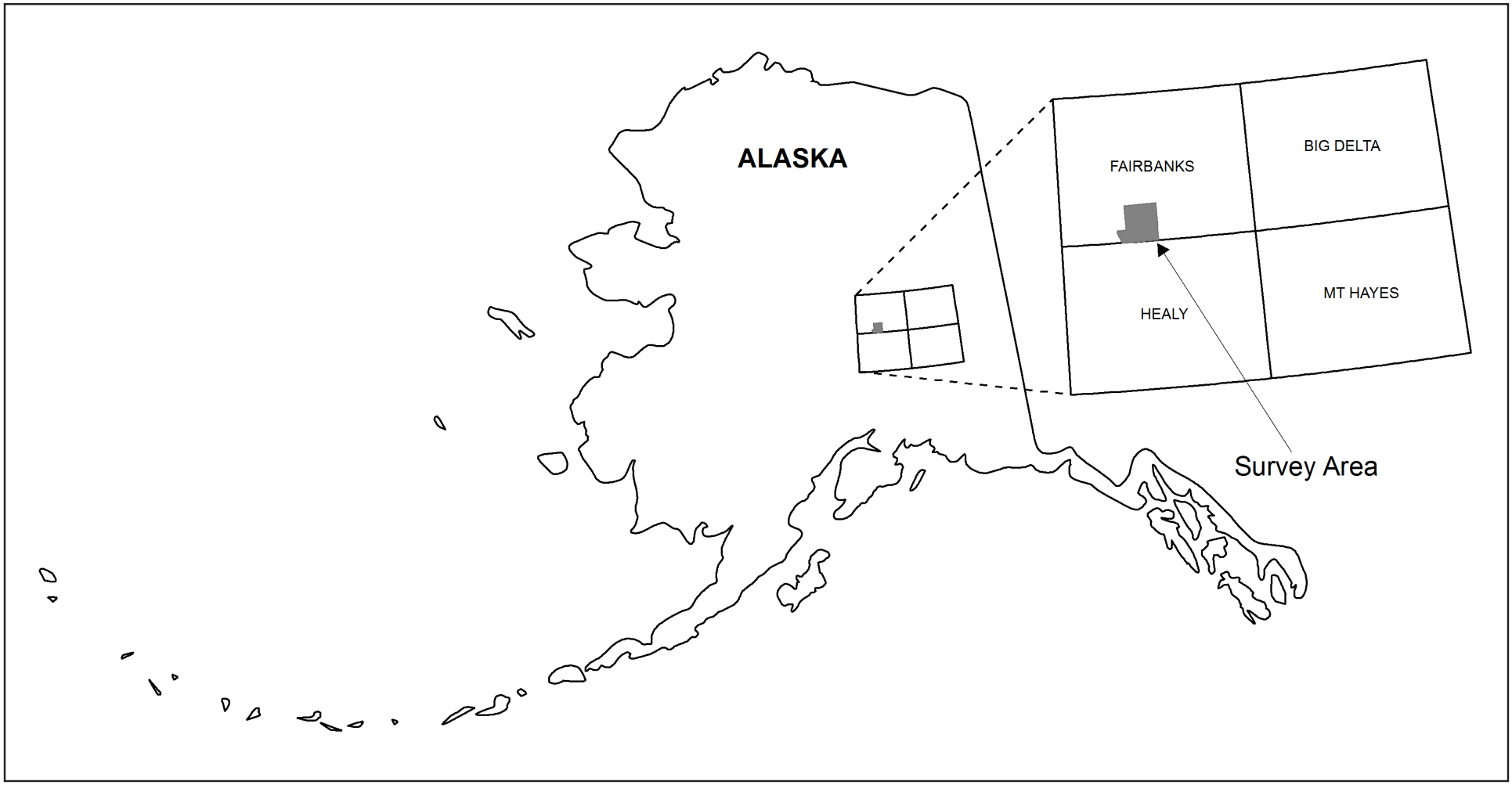


Figure 1. Liberty Bell survey area shown in relation to Fairbanks, Big Delta, Healy, and Mount Hayes 1:250,000-scale quadrangles.

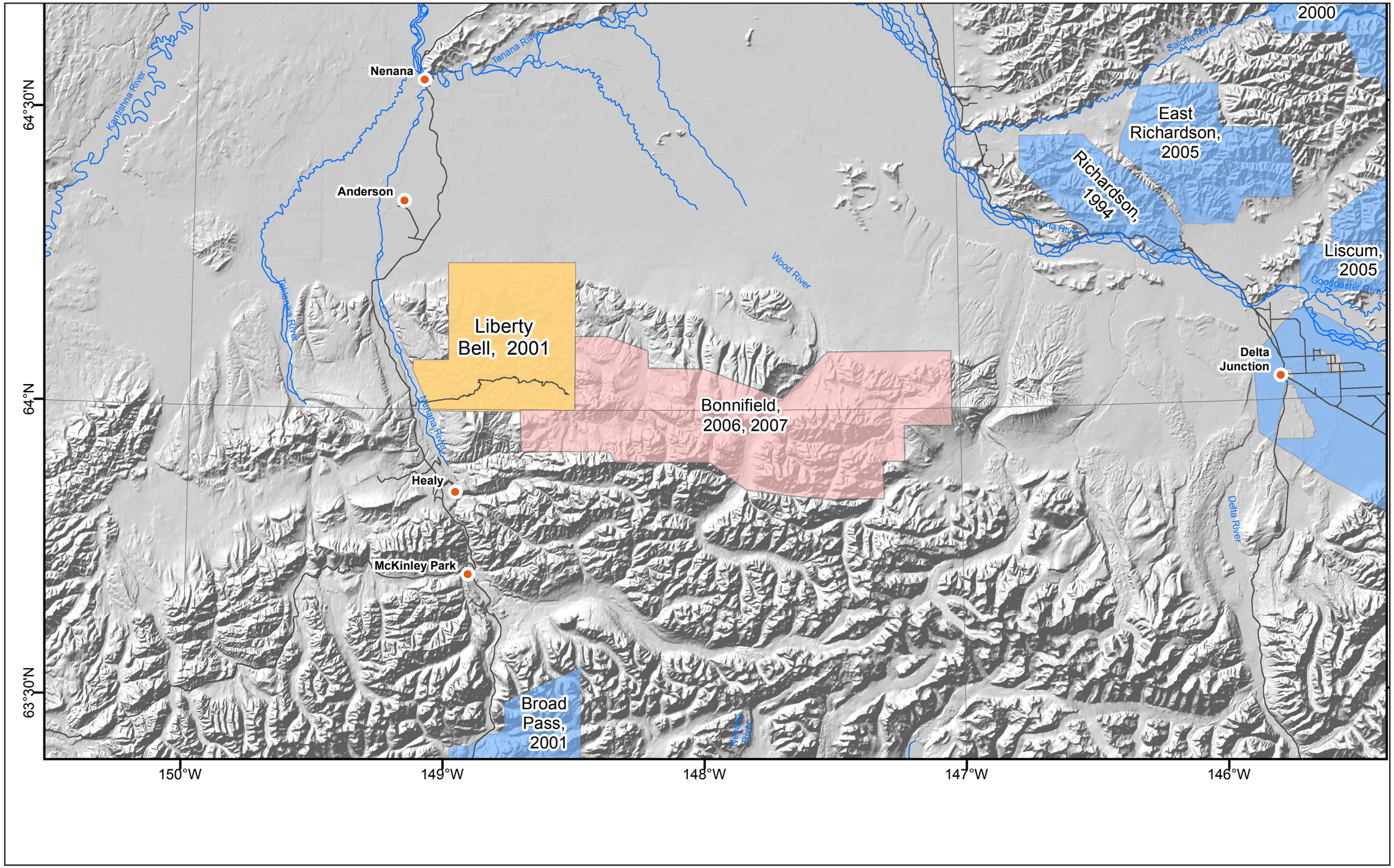


Figure 2. Liberty Bell survey location map. The Liberty Bell survey area is orange. The Bonnifield survey area, in red, was flown in 2006-2007. The data for these two surveys was merged later and is available as part of the products of the Bonnifield survey (http://doi.org/10.14509/29557) Prior survey areas are shaded blue. Highways, towns, rivers and relevant quadrangle boundaries are included for reference.

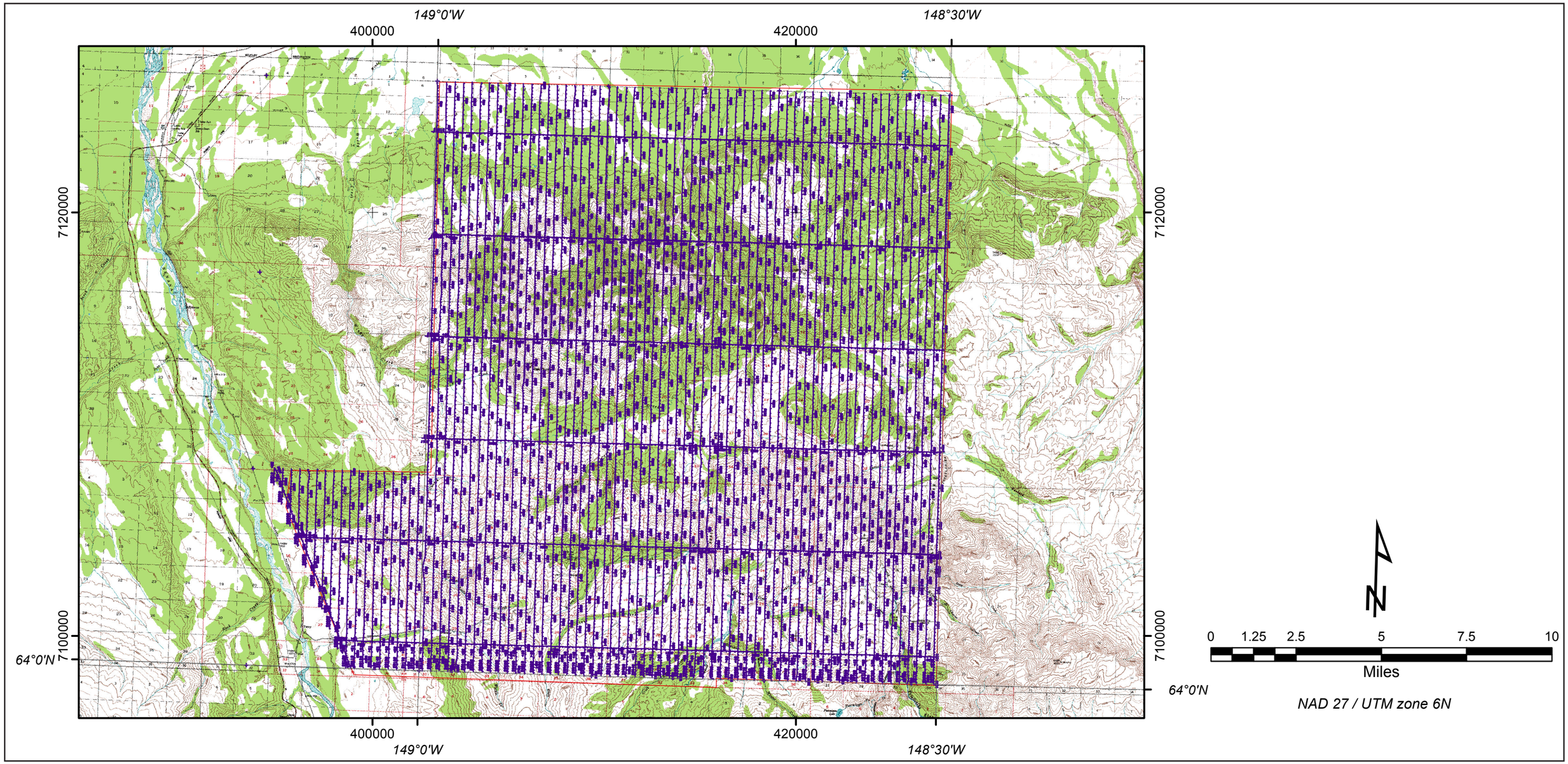


Figure 3. Flight lines and topography. **Data types:** Frequency domain electromagnetic and magnetic. **Frequencies:** coaxial 1000 and 5500 Hz; coplanar 900 Hz, 7200 Hz and 56000 Hz. **Line spacing:** 400 meters.

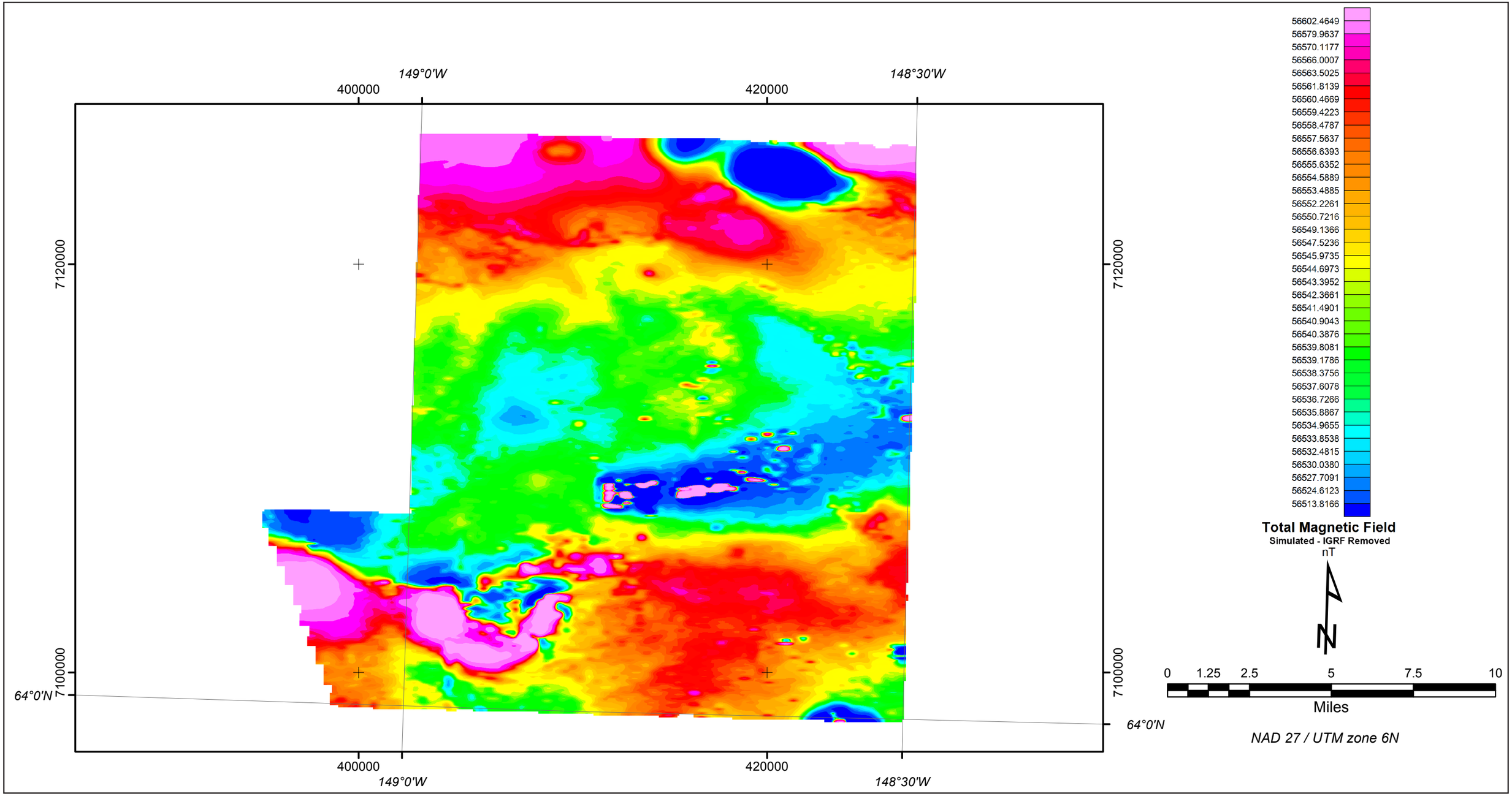


Figure 4. Simulated total magnetic field. The magnetic total field data were processed using digitally recorded data from a Picodas MEP-710 processor with Geometrics G822 sensor. Data were collected at a sampling interval of 0.1 seconds. In this publication's "older products and documentation" the magnetic data products have been referred to as Total Field Magnetics on the maps and the MAGIGRF channel in the line data and 'magigrf' as a filename abbreviation. The term simulated magnetic total field and the filename abbreviation 'sim_magtf' is now used to identify the final magnetic data. The new term 'sim_magtf' clarifies that the data are not representative of the true total magnetic field as the International Geomagnetic Reference Field (IGRF) values have been removed with a single average IGRF value added back to the data, resulting in the IGRF gradient being removed. Manual adjustments are applied to any lines that require levelling, as indicated by shadowed images of the gridded magnetic data or tie line/traverse line intercepts. The residual magnetic data have been presented on the base maps using a contour interval of 5 nT (nanoteslas). If a specific magnetic intensity can be assigned to the rock type which is believed to host the target mineralization, it may be possible to select areas of higher priority on the basis of the total field magnetic data. This is based on the assumption that the magnetite content of the host rocks will give rise to a limited range of contour values which will permit differentiation of various lithological units. The magnetic results, in conjunction with the other geophysical parameters, have provided valuable information which can be used to effectively map the geology and structure in the survey area. The total magnetic field data were (1) corrected for diurnal variations by subtraction of the digitally recorded base station magnetic data, (2) leveled to the tie line data, and (3) interpolated onto a regular 100 m grid using a modified Akima (1970) technique.

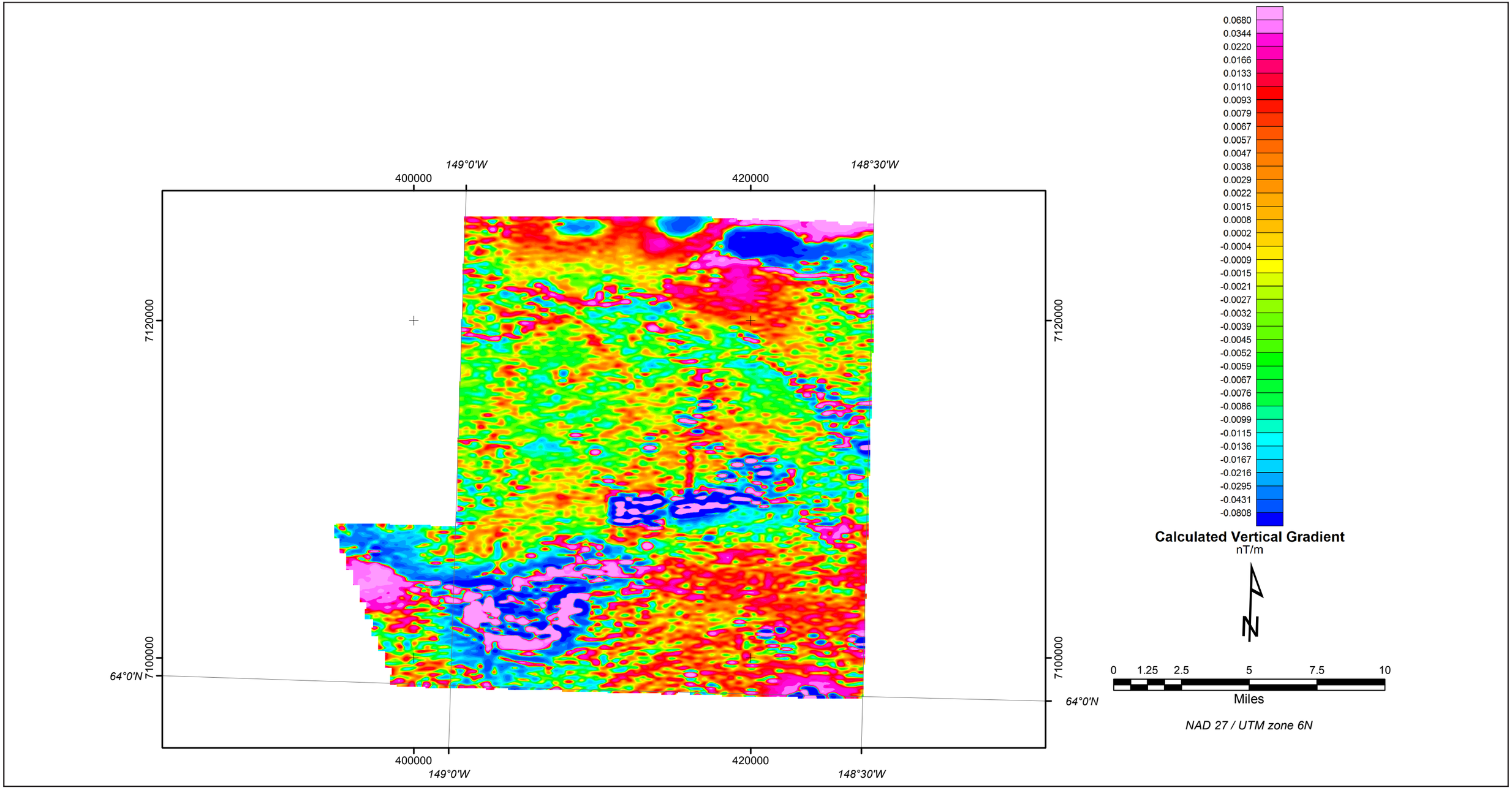


Figure 5. Calculated vertical gradient of the magnetic field. The magnetic total field data were processed using digitally recorded data from a Picodas MEP-710 processor with Geometrics G822 sensor. Data were collected at a sampling interval of 0.1 seconds. Manual adjustments are applied to any lines that require levelling, as indicated by shadowed images of the gridded magnetic data or tie line/traverse line intercepts. The IGRF gradient has been removed from the data. The residual magnetic data have been presented on the base maps using a contour interval of 5 nT. The total magnetic field data were (1) corrected for diurnal variations by subtraction of the digitally recorded base station magnetic data, (2) leveled to the tie line data, and (3) interpolated onto a regular 100 m grid using a modified Akima (1970) technique. The regional variation (or IGRF gradient, 2000, updated to August 2001) was removed from the leveled magnetic data. The first vertical derivative grid was calculated from the processed total magnetic field grid using a Fast Fourier Transform (FFT) base frequency domain filtering algorithm. The total magnetic field data were subjected to a processing algorithm that enhances the response of magnetic bodies in the upper 500 m and attenuates the response of deeper bodies. The resulting vertical gradient grid (*calculated1vd.grd) provides better definition and resolution of near-surface magnetic units. It also identifies weak magnetic features that may not be evident in the total field data.

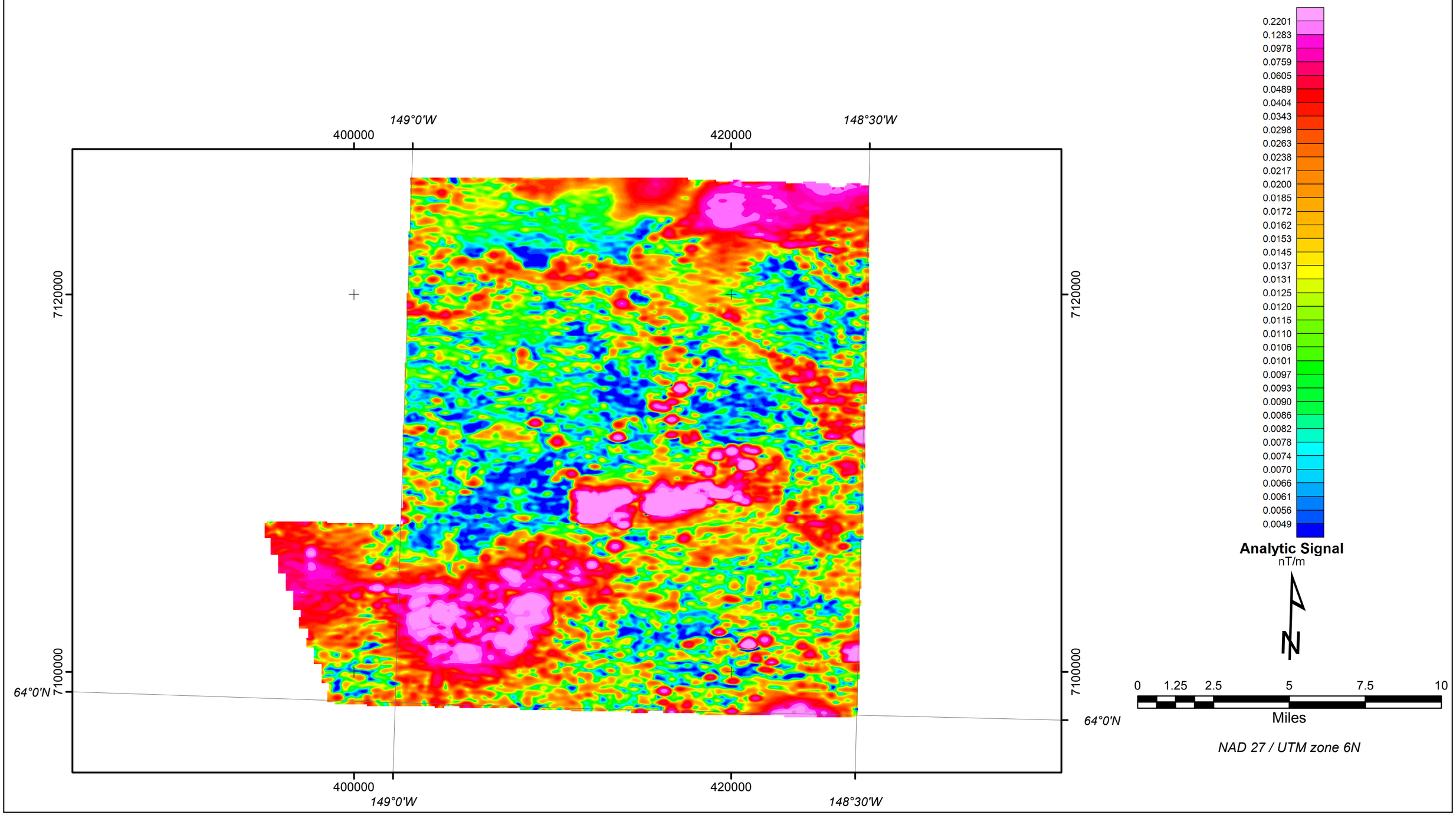


Figure 6. Analytic signal. Analytic signal is the total amplitude of all directions of magnetic gradient calculated from the sum of the squares of the three orthogonal gradients. Mapped highs in the calculated analytic signal of magnetic parameter locate the anomalous source body edges and corners (such as contacts, fault/shear zones, etc.). Analytic signal maxima are located directly over faults and contacts, regardless of structural dip, and independent of the direction of the induced and/or remanent magnetizations.

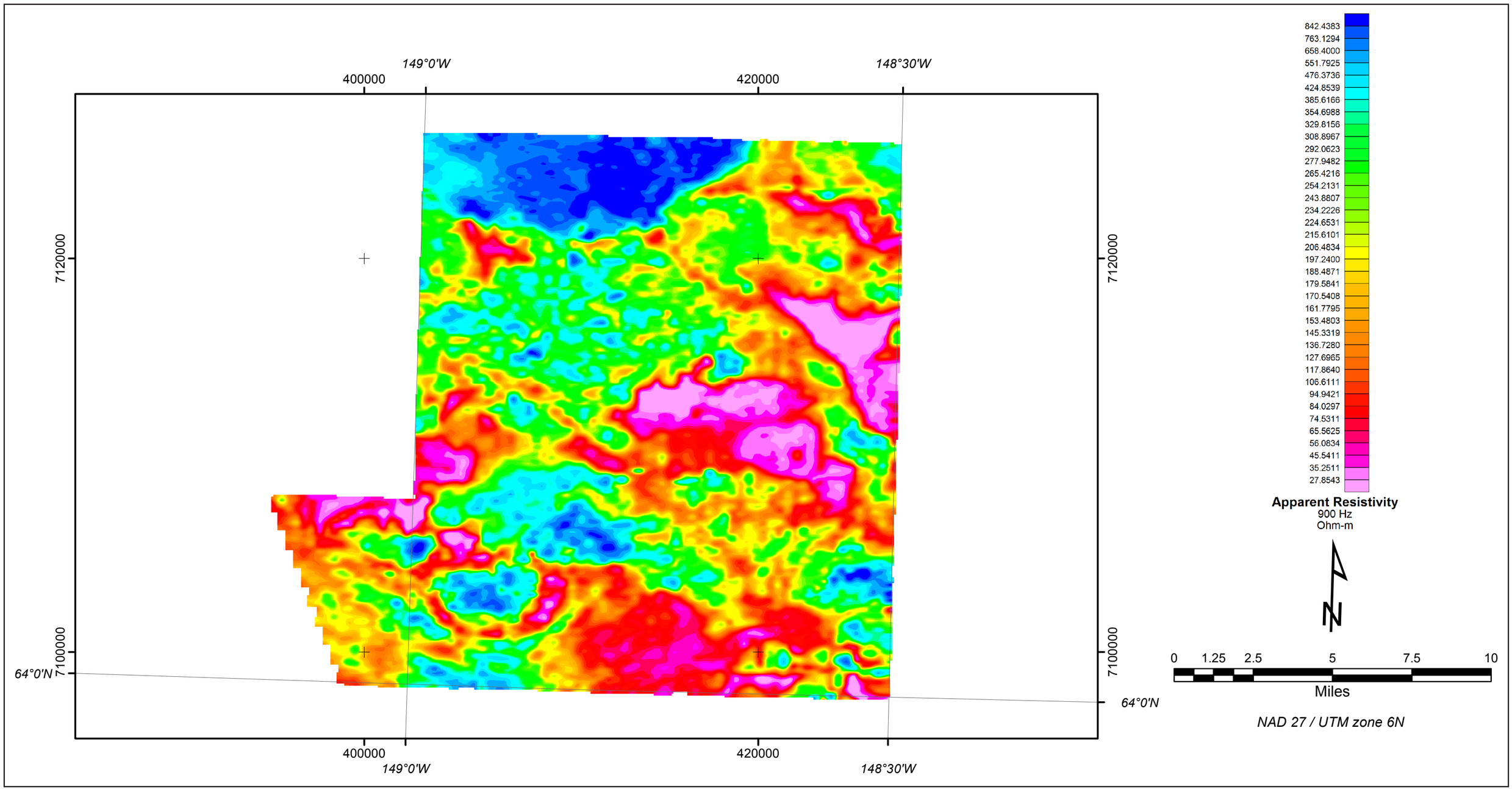


Figure 7. Resistivity 900 Hz Coplanar. The DIGHEM V EM system measured inphase and quadrature components at five frequencies. Two vertical coaxial-coil pairs operated at 1,072 (1,000) and 5,954 (5,500) Hz while three horizontal coplanar-coil pairs operated at 883 (900), 7,236 (7,200), and 55,360 (56,000) Hz. The EM data were sampled at 0.1 second intervals. The EM system responds to bedrock conductors, conductive overburden, and cultural sources. The EM inphase and quadrature data were drift corrected using base level data collected at high altitude (areas of no signal). Preliminary apparent resistivity maps and images are carefully inspected to identify lines or line segments which may require base level adjustment. Subtle changes between in-flight calibrations of the system can result in line to line differences which are more readily recognizable in resistive (low signal amplitude) areas. If required, manual level adjustments are carried out to eliminate or minimize resistivity differences which can be attributed in part to changes in operating temperature. These leveling adjustments are usually subtle, and do not result in the degradation of discrete anomalies. After the leveling process is complete, revised apparent resistivity grids are created. The resulting grid may be subjected to a microlevelling filter in order to smooth the data for contouring. The EM data were interpolated onto a regular 80 m grid using a modified Akima (1970) technique. The resulting grids were subjected to a 3x3 hanning filter before contouring and map production. This final filter will not degrade the apparent resistivity given the broad 'footprint' of the parameter and the assumption of a homogeneous half space inherent in the apparent resistivity computation. The calculated apparent resistivity values are clipped at a maximum value for each of the 900 and 7,200 Hz data sets. These maxima eliminate the meaningless high apparent resistivity values which would result from very small EM amplitudes. Contoured resistivity maps, based on the 900 Hz and 7,200 Hz coplanar data are included with this report. Values are in ohm-metres on all final products.

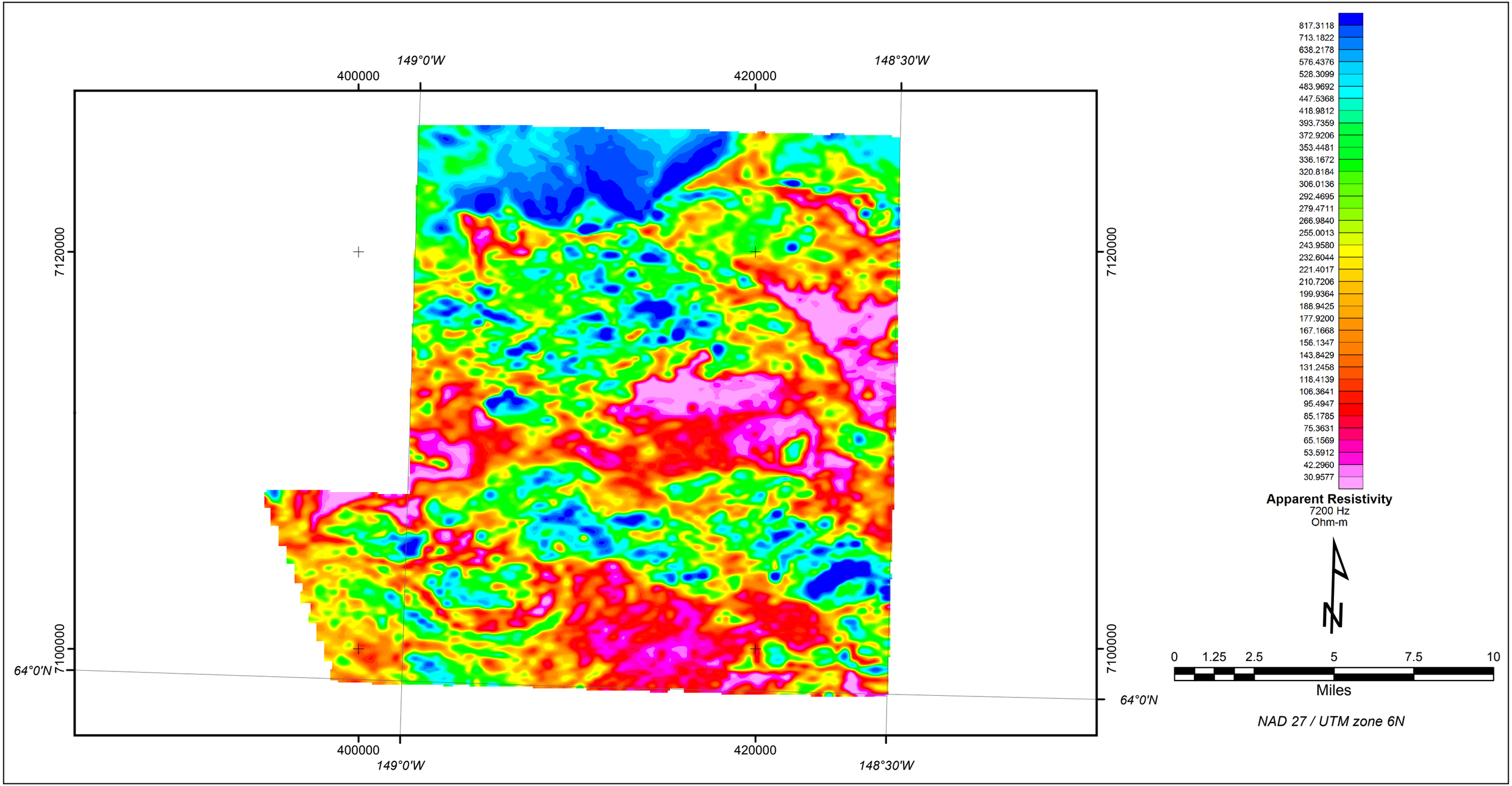


Figure 8. Resistivity 7200 Hz Coplanar. The DIGHEM V EM system measured inphase and quadrature components at five frequencies. Two vertical coaxial-coil pairs operated at 1,072 (1,000) and 5,954 (5,500) Hz while three horizontal coplanar-coil pairs operated at 883 (900), 7,236 (7,200), and 55,360 (56,000) Hz. The EM data were sampled at 0.1 second intervals. The EM system responds to bedrock conductors, conductive overburden, and cultural sources. The EM inphase and quadrature data were drift corrected using base level data collected at high altitude (areas of no signal). Preliminary apparent resistivity maps and images are carefully inspected to identify lines or line segments which may require base level adjustment. Subtle changes between in-flight calibrations of the system can result in line to line differences which are more readily recognizable in resistive (low signal amplitude) areas. If required, manual level adjustments are carried out to eliminate or minimize resistivity differences which can be attributed in part to changes in operating temperature. These leveling adjustments are usually subtle, and do not result in the degradation of discrete anomalies. After the leveling process is complete, revised apparent resistivity grids are created. The resulting grid may be subjected to a microlevelling filter in order to smooth the data for contouring. The EM data were interpolated onto a regular 80 m grid using a modified Akima (1970) technique. The resulting grids were subjected to a 3x3 hanning filter before contouring and map production.This final filter will not degrade the apparent resistivity given the broad 'footprint' of the parameter and the assumption of a homogeneous half space inherent in the apparent resistivity computation. The calculated apparent resistivity values are clipped at a maximum value for each of the 900 and 7,200 Hz data sets. These maxima eliminate the meaningless high apparent resistivity values which would result from very small EM amplitudes. Contoured resistivity maps, based on the 900 Hz and 7,200 Hz coplanar data are included with this report. Values are in ohm-metres on all final products.

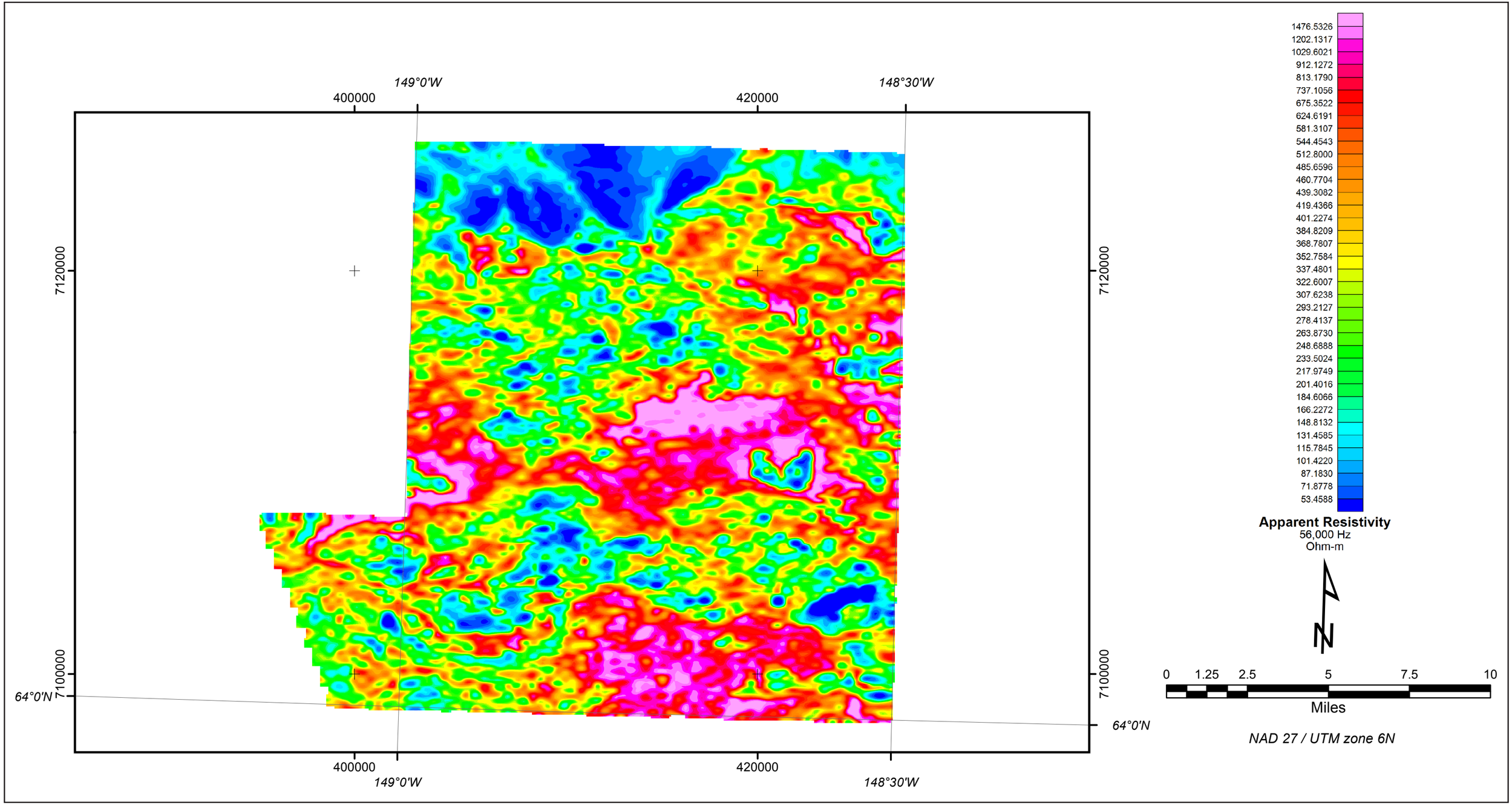
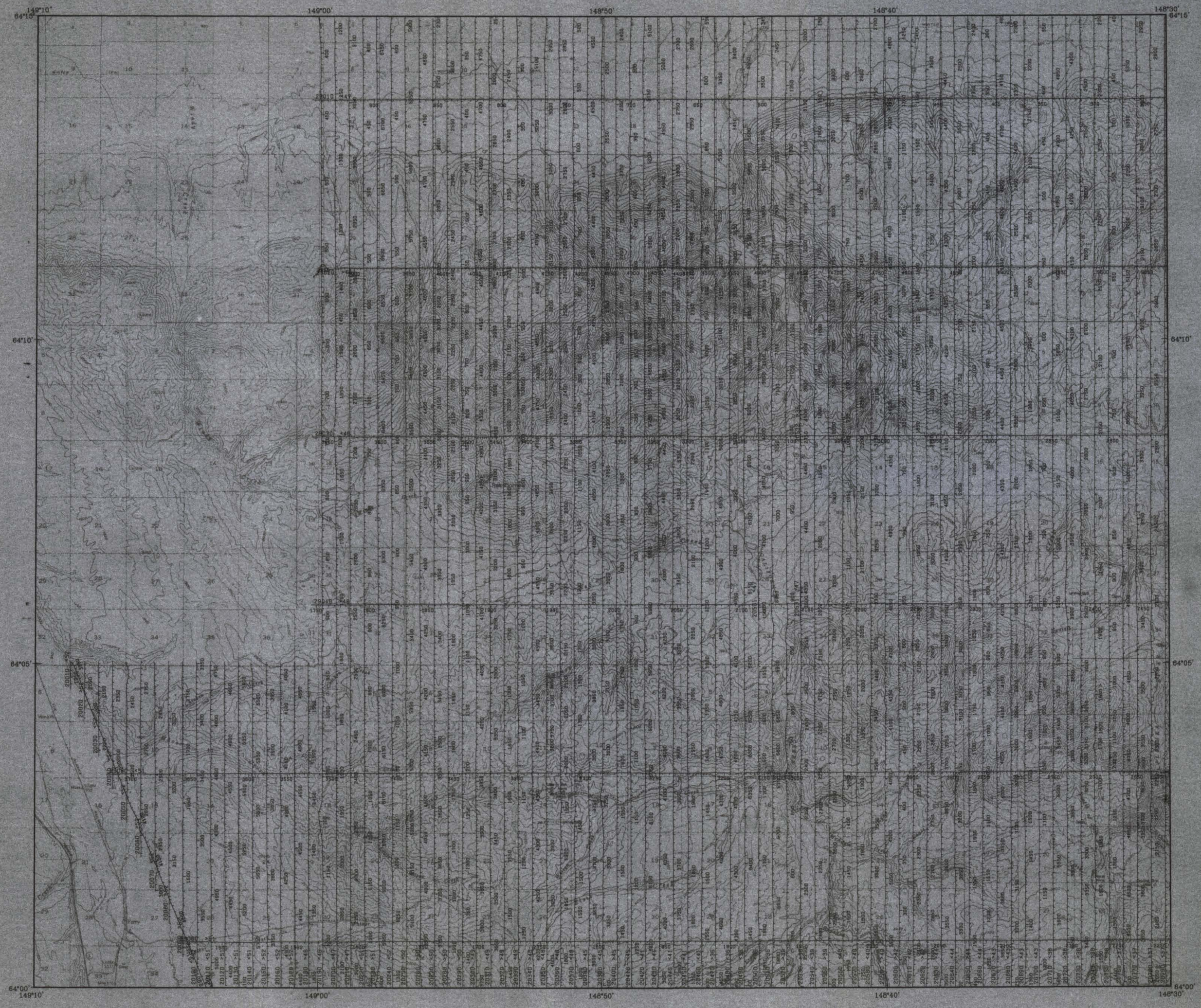


Figure 9. Resistivity 56,000 Hz Coplanar. The DIGHEM V EM system measured inphase and quadrature components at five frequencies. Two vertical coaxial-coil pairs operated at 1,072 (1,000) and 5,954 (5,500) Hz while three horizontal coplanar-coil pairs operated at 883 (900), 7,236 (7,200), and 55,360 (56,000) Hz. The EM data were sampled at 0.1 second intervals. The EM system responds to bedrock conductors, conductive overburden, and cultural sources. The EM inphase and quadrature data were drift corrected using base level data collected at high altitude (areas of no signal). Preliminary apparent resistivity maps and images are carefully inspected to identify lines or line segments which may require base level adjustment. Subtle changes between in-flight calibrations of the system can result in line to line differences which are more readily recognizable in resistive (low signal amplitude) areas. If required, manual level adjustments are carried out to eliminate or minimize resistivity differences which can be attributed in part to changes in operating temperature. These leveling adjustments are usually subtle, and do not result in the degradation of discrete anomalies. After the leveling process is complete, revised apparent resistivity grids are created. The resulting grid may be subjected to a microlevelling filter in order to smooth the data for contouring. The EM data were interpolated onto a regular 80 m grid using a modified Akima (1970) technique. The resulting grids were subjected to a 3x3 hanning filter before contouring and map production.This final filter will not degrade the apparent resistivity given the broad 'footprint' of the parameter and the assumption of a homogeneous half space inherent in the apparent resistivity computation. The calculated apparent resistivity values are clipped at a maximum value for each of the 900 and 7,200 Hz data sets. These maxima eliminate the meaningless high apparent resistivity values which would result from very small EM amplitudes. Contoured resistivity maps, based on the 900 Hz and 7,200 Hz coplanar data are included with this report. Values are in ohm-metres on all final products.

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/10.14509/29690.

Map Number	Map Title	Description	Scale
Geophysical Report 2002_6_5a	Flight lines of the Liberty Bell area, western Bonnifield mining district, central Alaska	Flight lines with topography	1:63,360
Geophysical Report 2002_6_1a	Total magnetic field of the Liberty Bell area, western Bonnifield mining district, central Alaska	Color total magnetic field with topography	1:63,360
Geophysical Report 2002_6_1b	Total magnetic field of the Liberty Bell area, western Bonnifield mining district, central Alaska	Color total magnetic field with contours and sections lines	1:63,360
Geophysical Report 2002_6_1c	Color shadow magnetic map of the Liberty Bell area, western Bonnifield mining district, central Alaska	Color shadow total magnetic field with section lines	1:63,360
Geophysical Report 2002_6_1d	Total magnetic field and electromagnetic anomalies of the Liberty Bell area, western Bonnifield mining district, central Alaska	Black and white total magnetic field contours with section lines and simplified EM anomalies	1:63,360
Geophysical Report 2002_6_2a	Total magnetic field and detailed electromagnetic anomalies of the Liberty Bell area, western Bonnifield mining district, central Alaska, part of northern Fairbanks A-4 Quadrangle	Black and white total magnetic field contours with detailed EM anomalies and topography	1:31,680
Geophysical Report 2002_6_2b	Total magnetic field and detailed electromagnetic anomalies of the Liberty Bell area, western Bonnifield mining district, central Alaska, part of southern Fairbanks A-4 and A-5 quadrangles	Black and white total magnetic field contours with detailed EM anomalies and topography	1:31,680
Geophysical Report 2002_6_3a	7200 Hz coplanar resistivity of the Liberty Bell area, western Bonnifield mining district, central Alaska	Color resistivity (7200 hz coplanar) with topography	1:63,360
Geophysical Report 2002_6_3b	7200 Hz coplanar resistivity of the Liberty Bell area, western Bonnifield mining district, central Alaska	Color resistivity (7200 hz coplanar) with contours and section lines	1:63,360
Geophysical Report 2002_6_3c	7200 Hz coplanar resistivity of the Liberty Bell area, western Bonnifield mining district, central Alaska	Black and white resistivity (7200 hz coplanar) contours with section lines	1:63,360
Geophysical Report 2002_6_4a	900 Hz coplanar resistivity of the Liberty Bell area, western Bonnifield mining district, central Alaska	Color resistivity (900 hz coplanar) with topography	1:63,360
Geophysical Report 2002_6_4b	900 Hz coplanar resistivity of the Liberty Bell area, western Bonnifield mining district, central Alaska	Color resistivity (900 hz coplanar) with contours and section lines	1:63,360
Geophysical Report 2002_6_4c	900 Hz coplanar resistivity of the Liberty Bell area, western Bonnifield mining district, central Alaska	Black and white resistivity (900 hz coplanar) contours with section lines	1:63,360
Geophysical Report 2002_9	Interpretation map of the Liberty Bell area, western Bonnifield mining district, central Alaska	Interpretation map with section lines	1:63,360



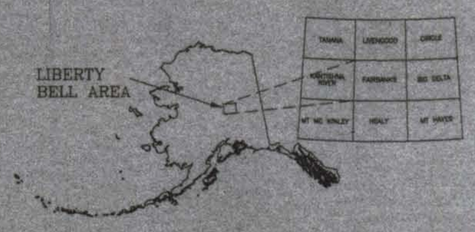
Base from U.S. Geological Survey Fairbanks A-4, 1972; Fairbanks A-5, 1984; Quadrangles, Alaska

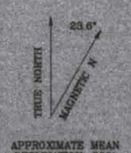
SCALE 1:63,360

1 0 1 2 3 4 MILES

1 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 100 FEET
DATUM MEAN SEA LEVEL





APPROXIMATE MEAN DECLINATION, 2001

FLIGHT LINES OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, CENTRAL ALASKA

PARTS OF FAIRBANKS QUADRANGLE

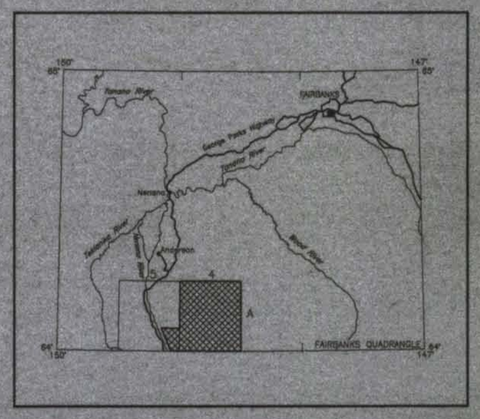
2002

DESCRIPTIVE NOTES

The geophysical data were acquired with a DIGHEM^V Electromagnetic (EM) system and a Scintrex cesium magnetometer. Both were flown at a height of 100 feet. In addition the survey recorded data from a radar altimeter, GPS navigation system, 50/60 Hz monitors and video camera. Flights were performed with an AS350B-2 Squirrel helicopter at a mean terrain clearance of 200 feet along North-South (0°) survey flight lines with a spacing of a quarter of a mile. Tie lines were flown perpendicular to the flight lines at intervals of approximately 3 miles. The blank regions indicate an area where the survey aircraft had to detour around populated areas.

An Ashtech GG24 NAVSTAR / GLONASS Global Positioning System was used for navigation. The helicopter position was derived every 0.5 seconds using post-flight differential positioning to a relative accuracy of better than 5 m. Flight path positions were projected onto the Clarke 1866 (UTM zone 6) spheroid, 1927 North American datum using a central meridian (CM) of 147°, a north constant of 0 and an east constant of 500,000. Positional accuracy of the presented data is better than 10 m with respect to the UTM grid.

LOCATION INDEX

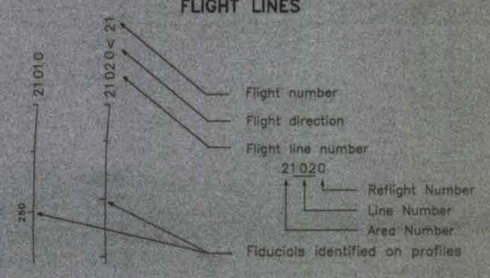


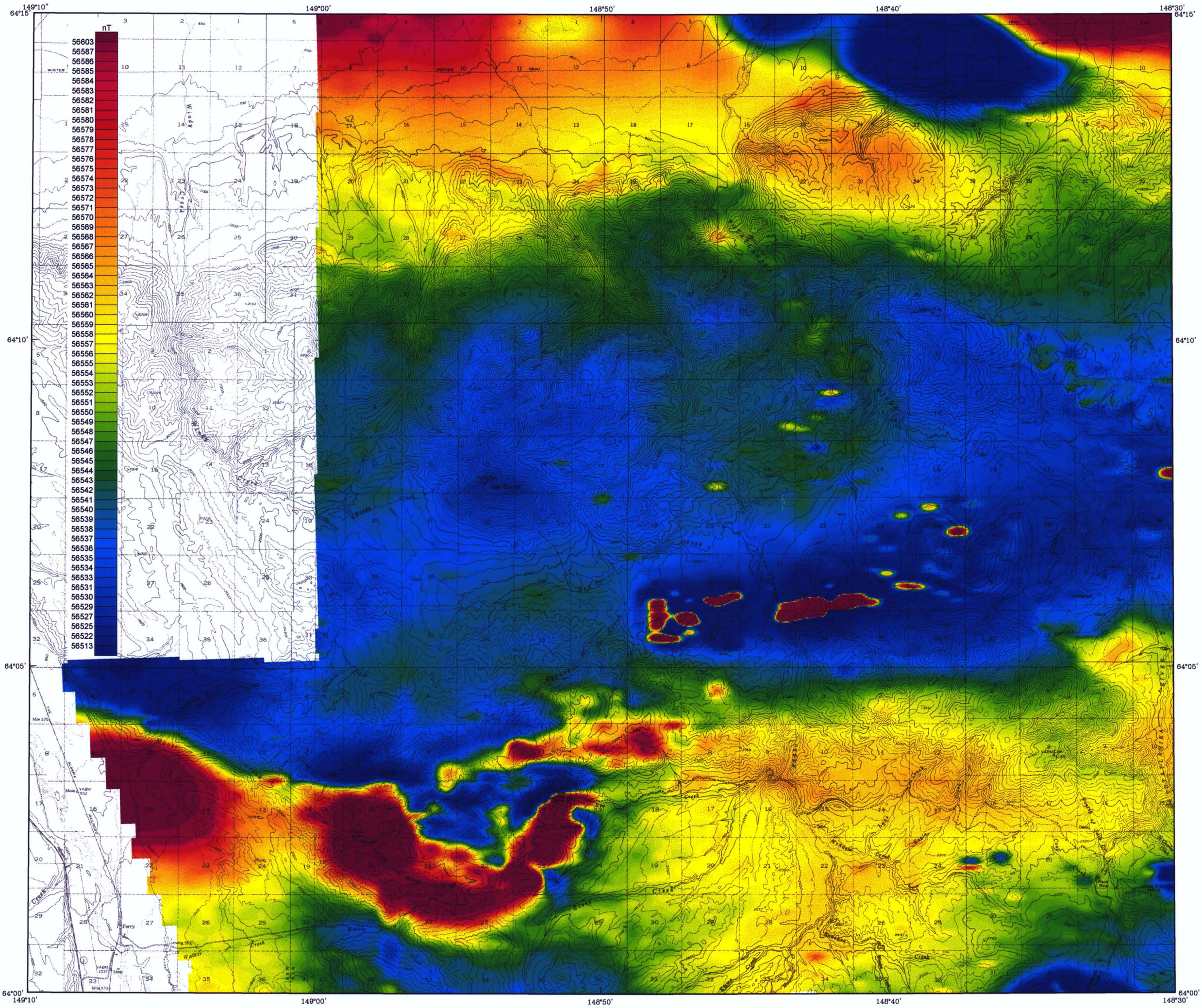
SURVEY HISTORY

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 Stevens Exploration Management Corp. Airborne geophysical data for the area were acquired and processed by Fugro Airborne Surveys in 2001. Laurel Burns was the contract manager for DGGS.

This map and other products from this survey are available by mail order or in person from DGGS, 794 University Ave., Suite 200, Fairbanks, Alaska, 99709.

FLIGHT LINES





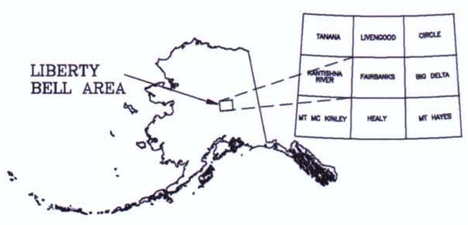
Base from U.S. Geological Survey Fairbanks A-4, 1972; Fairbanks A-5, 1984; Quadrangles, Alaska

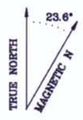
SCALE 1:63,360

1 0 1 2 3 4 MILES

1 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 100 FEET
DATUM MEAN SEA LEVEL





APPROXIMATE MEAN DECLINATION, 2001

TOTAL MAGNETIC FIELD OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, CENTRAL ALASKA

PARTS OF FAIRBANKS QUADRANGLE

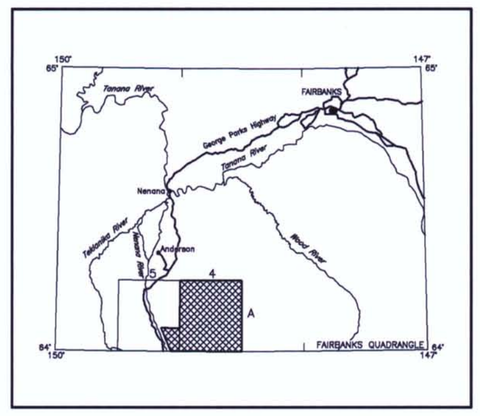
2002

DESCRIPTIVE NOTES

The geophysical data were acquired with a DIGHEM^V Electromagnetic (EM) system and a Scintrex cesium magnetometer. Both were flown at a height of 100 feet. In addition the survey recorded data from a radar altimeter, GPS navigation system, 50/60 Hz monitors and video camera. Flights were performed with an AS350B-2 Squirrel helicopter at a mean terrain clearance of 200 feet along North-South (0°) survey flight lines with a spacing of a quarter of a mile. Tie lines were flown perpendicular to the flight lines at intervals of approximately 3 miles. The blank regions indicate an area where the survey aircraft had to detour around populated areas.

An Ashtech GG24 NAVSTAR / GLONASS Global Positioning System was used for navigation. The helicopter position was derived every 0.5 seconds using post-flight differential positioning to a relative accuracy of better than 5 m. Flight path positions were projected onto the Clarke 1866 (UTM zone 6) spheroid, 1927 North American datum using a central meridian (CM) of 147°, a north constant of 0 and an east constant of 500,000. Positional accuracy of the presented data is better than 10 m with respect to the UTM grid.

LOCATION INDEX



SURVEY HISTORY

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TOTAL MAGNETIC FIELD

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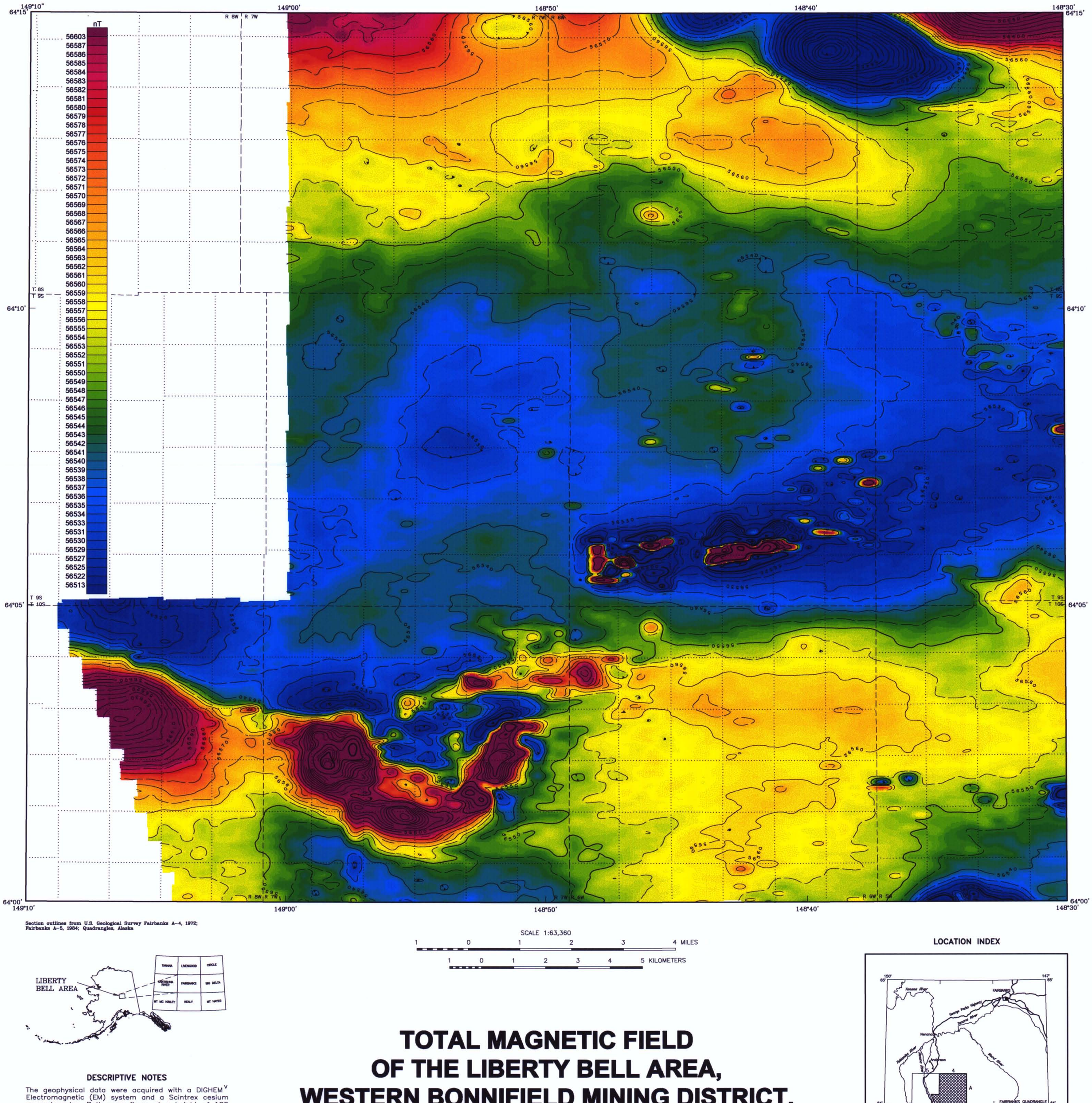
Akima, H., 1970, A new method of interpolation and smooth curve fitting based on local procedures: Journal of the Association of Computing Machinery, v. 17, no. 4, p. 589-602.



Section outlines from U.S. Geological Survey Fairbanks A–4, 1972; Fairbanks A–5, 1984; Quadrangles, Alaska

SCALE 1:63,360

1 0 1 2 3 4 MILES

1 0 1 2 3 4 5 KILOMETERS

TOTAL MAGNETIC FIELD OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, CENTRAL ALASKA

PARTS OF FAIRBANKS QUADRANGLE

2002

DESCRIPTIVE NOTES

The geophysical data were acquired with a DIGHEM^V Electromagnetic (EM) system and a Scintrex cesium magnetometer. Both were flown at a height of 100 feet. In addition the survey recorded data from a radar altimeter, GPS navigation system, 50/60 Hz monitors and video camera. Flights were performed with an AS350B–2 Squirrel helicopter at a mean terrain clearance of 200 feet along North–South (0°) survey flight lines with a spacing of a quarter of a mile. Tie lines were flown perpendicular to the flight lines at intervals of approximately 3 miles. The blank regions indicate an area where the survey aircraft had to detour around populated areas.

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Akima, H., 1970, A new method of interpolation and smooth curve fitting based on local procedures: Journal of the Association of Computing Machinery, v. 17, no. 4, p. 589–602.

APPROXIMATE MEAN DECLINATION, 2001

LOCATION INDEX

SURVEY HISTORY

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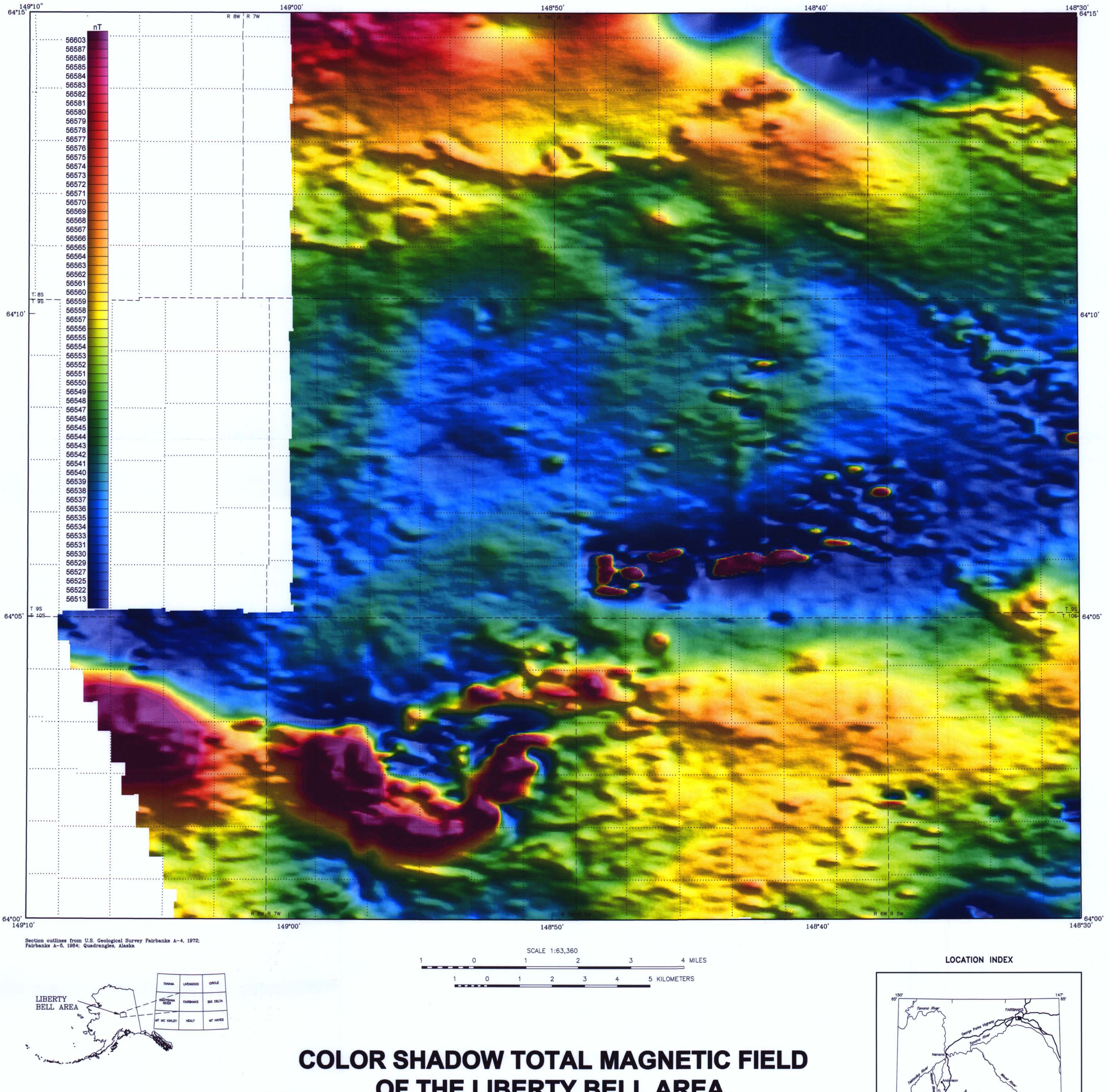
MAGNETIC CONTOUR INTERVAL

250 nT

50 nT

10 nT

5 nT



Section outlines from U.S. Geological Survey Fairbanks A-4, 1972; Fairbanks A-5, 1984; Quadrangles, Alaska

SCALE 1:63,360

1 0 1 2 3 4 MILES

1 0 1 2 3 4 5 KILOMETERS

APPROXIMATE MEAN DECLINATION, 2001

COLOR SHADOW TOTAL MAGNETIC FIELD OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, CENTRAL ALASKA

PARTS OF FAIRBANKS QUADRANGLE

2002

Sun Azimuth: 45 degrees

Sun Inclination: 35 degrees

LOCATION INDEX

DESCRIPTIVE NOTES

The geophysical data were acquired with a DIGHEM^{V} Electromagnetic (EM) system and a Scintrex cesium magnetometer. Both were flown at a height of 100 feet. In addition the survey recorded data from a radar altimeter, GPS navigation system, 50/60 Hz monitors and video camera. Flights were performed with an AS350B-2 Squirrel helicopter at a mean terrain clearance of 200 feet along North-South (0°) survey flight lines with a spacing of a quarter of a mile. Tie lines were flown perpendicular to the flight lines at intervals of approximately 3 miles. The blank regions indicate an area where the survey aircraft had to detour around populated areas.

An Ashtech GG24 NAVSTAR / GLONASS Global Positioning System was used for navigation. The helicopter position was derived every 0.5 seconds using post-flight differential positioning to a relative accuracy of better than 5 m. Flight path positions were projected onto the Clarke 1866 (UTM zone 6) spheroid, 1927 North American datum using a central meridian (CM) of 147°, a north constant of 0 and an east constant of 500,000. Positional accuracy of the presented data is better than 10 m with respect to the UTM grid.

SURVEY HISTORY

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TOTAL MAGNETIC FIELD

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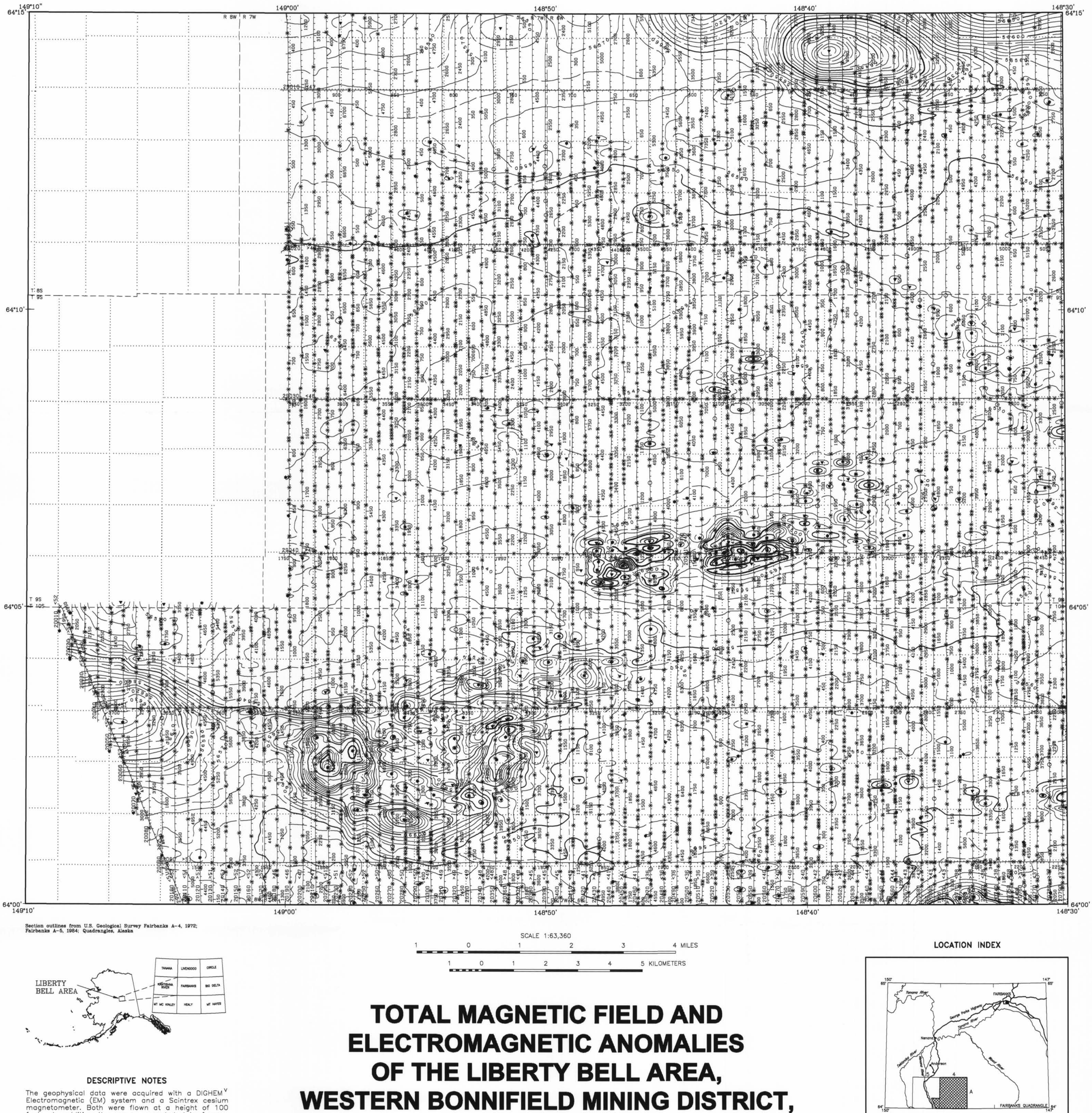

Section outlines from U.S. Geological Survey Fairbanks A–4, 1972; Fairbanks A–5, 1984; Quadrangles, Alaska

SCALE 1:63,360

1 0 1 2 3 4 MILES

1 0 1 2 3 4 5 KILOMETERS

TOTAL MAGNETIC FIELD AND ELECTROMAGNETIC ANOMALIES OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, CENTRAL ALASKA

PARTS OF FAIRBANKS QUADRANGLE

2002

DESCRIPTIVE NOTES

The geophysical data were acquired with a DIGHEM^{V} Electromagnetic (EM) system and a Scintrex cesium magnetometer. Both were flown at a height of 100 feet. In addition the survey recorded data from a radar altimeter, GPS navigation system, 50/60 Hz monitors and video camera. Flights were performed with an AS350B–2 Squirrel helicopter at a mean terrain clearance of 200 feet along North–South (0°) survey flight lines with a spacing of a quarter of a mile. Tie lines were flown perpendicular to the flight lines at intervals of approximately 3 miles. The blank regions indicate an area where the survey aircraft had to detour around populated areas.

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ELECTROMAGNETICS

To determine the location of EM anomalies or their boundaries, the DIGHEM^{V} EM system measured inphase and quadrature components at five frequencies. Two vertical coaxial–coil pairs operated at 1000 and 5500 Hz while three horizontal coplanar–coil pairs operated at 900, 7200, and 56,000 Hz. EM data were sampled at 0.1 second intervals. The EM system responds to bedrock conductors, conductive overburden, and cultural sources. The power line monitor and the flight track video were examined to locate cultural sources. The EM anomalies that are indicated are classified by conductance.

APPROXIMATE MEAN DECLINATION, 2001

ELECTROMAGNETIC ANOMALIES

Anomaly	Conductance
●	>50 siemens
○	<50 siemens
✳	Questionable anomaly
△	Weak conductivity associated with an EM magnetite response

MAGNETIC CONTOUR INTERVAL

250 nT

50 nT

10 nT

5 nT

magnetic low

magnetic high

LOCATION INDEX

SURVEY HISTORY

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Akima, H., 1970, A new method of interpolation and smooth curve fitting based on local procedures: Journal of the Association of Computing Machinery, v. 17, no. 4, p. 589–602.

GEOPHYSICAL REPORT 2002_6_2a
PART OF FAIRBANKS A-4 QUADRANGLE

149°00' 148°50' 148°40' 148°30'
64°15' 64°10' 64°07'30"

Base from U.S. Geological Survey Fairbanks A-4, 1972; Quadrangle, Alaska

SCALE 1:31,680

0.5 0 0.5 1 1.5 2 MILES

0.5 0 0.5 1 1.5 2 2.5 KILOMETERS

CONTOUR INTERVAL 100 FEET
DATUM MEAN SEA LEVEL

TOTAL MAGNETIC FIELD AND DETAILED ELECTROMAGNETIC ANOMALIES OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, CENTRAL ALASKA

PART OF FAIRBANKS A-4 QUADRANGLE

2002

DESCRIPTIVE NOTES

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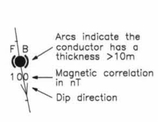
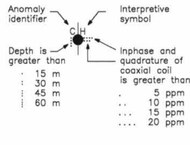
ELECTROMAGNETICS

To determine the location of EM anomalies or their boundaries, the DIGHEM^V EM system measured inphase and quadrature components at five frequencies. Two vertical coaxial–coil pairs operated at 1000 and 5500 Hz while three horizontal coplanar–coil pairs operated at 900, 7200, and 56,000 Hz. EM data were sampled at 0.1 second intervals. The EM system responds to bedrock conductors, conductive overburden, and cultural sources. The type of conductor is indicated on the aeromagnetic map by the interpretive symbol attached to each EM anomaly. Determination of the type of conductor is based on EM anomaly shapes of the coaxial– and coplanar–coil responses, together with conductor and magnetic patterns and topography. The power line monitor and the flight track video were examined to locate cultural sources.

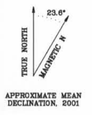
ELECTROMAGNETIC ANOMALIES



Anomaly	Conductance
●	>100 siemens
◕	50–100 siemens
◒	20–50 siemens
◔	10–20 siemens
⊕	5–10 siemens
○	1–5 siemens
◌	< 1 siemens
✳	Questionable anomaly
△^{M}	EM magnetite response



Interpretive symbol	Conductor ("model")
B	Bedrock conductor
D	Narrow bedrock conductor ("thin dike")
S	Conductive cover ("horizontal thin sheet")
H	Broad conductive rock unit, deep conductive weathering, thick conductive cover ("half space")
E	Edge of broad conductor ("edge of half space")
L	Culture, e.g., power line, metal building or fence

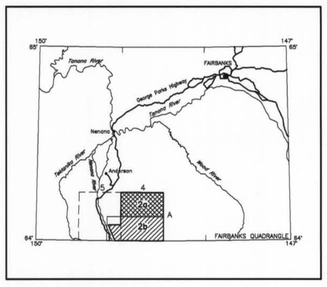


APPROXIMATE MEAN DECLINATION, 2001

MAGNETIC CONTOUR INTERVAL

- ..... 250 nT
- ..... 50 nT
- ..... 10 nT
- ..... 5 nT
- ..... magnetic low
- ..... magnetic high

LOCATION INDEX FOR SCALE 1:31,680



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Base from U.S. Geological Survey Fairbanks A-4, 1972; Fairbanks A-5, 1984; Quadrangles, Alaska

SCALE 1:31,680

0.5 0 0.5 1 1.5 2 MILES

0.5 0 0.5 1 1.5 2 2.5 KILOMETERS

CONTOUR INTERVAL 100 FEET
DATUM MEAN SEA LEVEL

TOTAL MAGNETIC FIELD AND DETAILED ELECTROMAGNETIC ANOMALIES OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, CENTRAL ALASKA

PARTS OF FAIRBANKS A-4 AND A-5 QUADRANGLES

2002

DESCRIPTIVE NOTES

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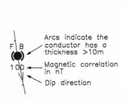
ELECTROMAGNETIC ANOMALIES



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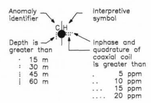

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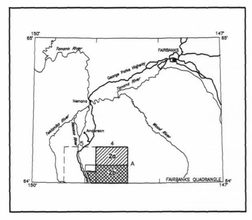
E	Edge of broad conductor ("edge of half space")
L	Culture, e.g., power line, metal building or fence

APPROXIMATE MEAN DECLINATION, 2001

MAGNETIC CONTOUR INTERVAL

250 nT
50 nT
10 nT
5 nT
magnetic low
magnetic high

LOCATION INDEX FOR SCALE 1:31,680



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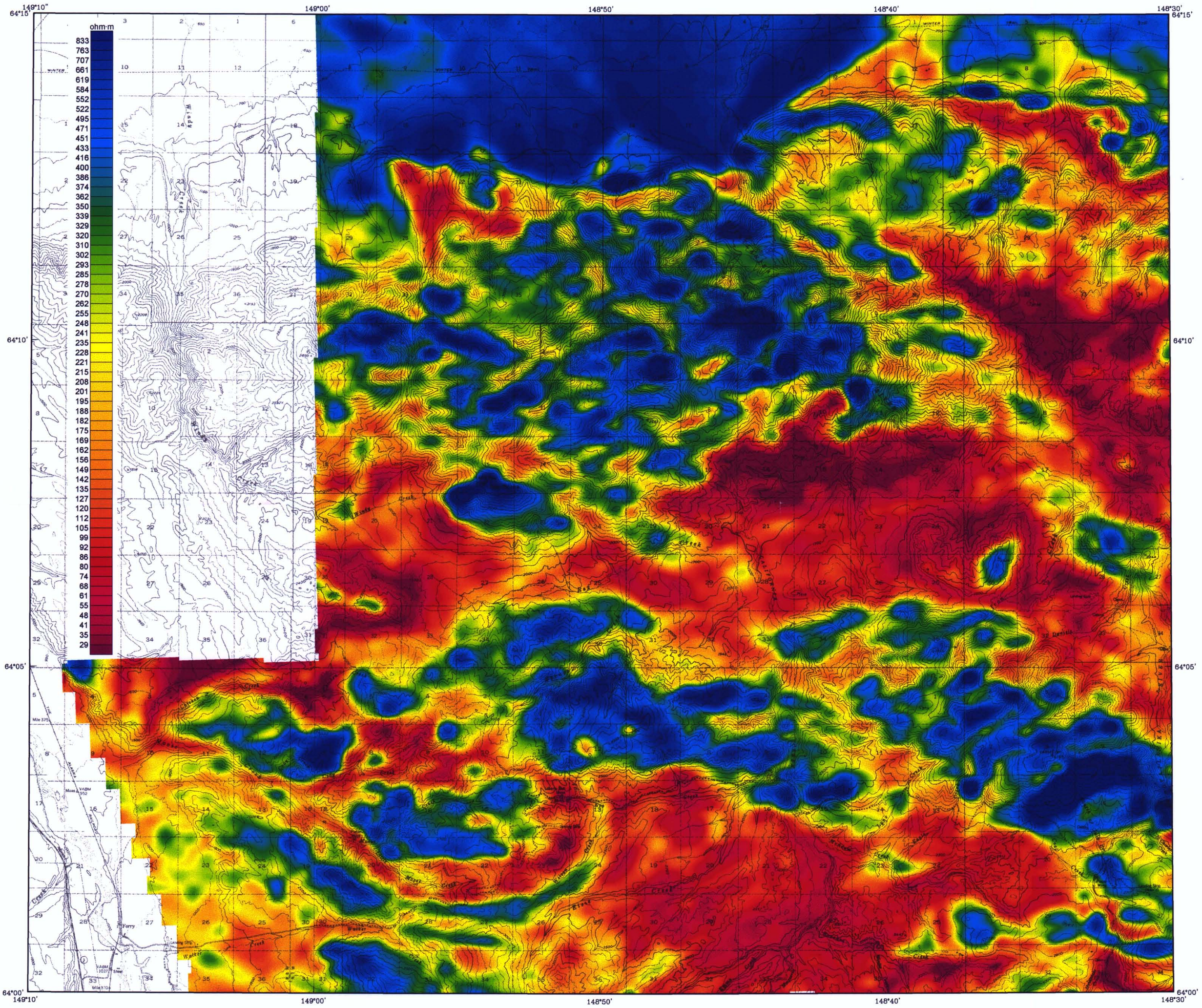


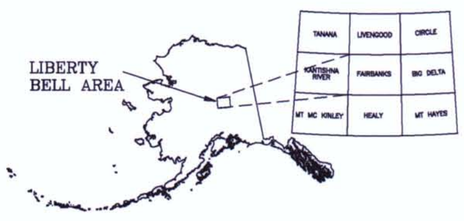
Base from U.S. Geological Survey Fairbanks A–4, 1972; Fairbanks A–5, 1984; Quadrangles, Alaska

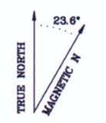
SCALE 1:63,360

1 0 1 2 3 4 MILES

1 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 100 FEET
DATUM MEAN SEA LEVEL





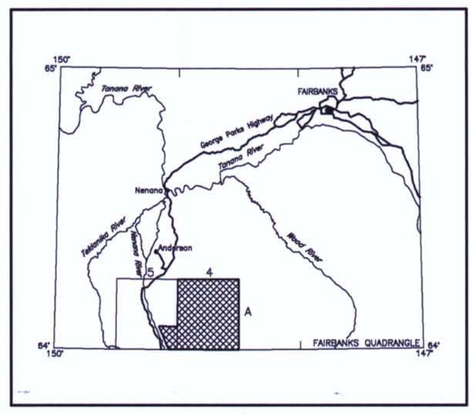
APPROXIMATE MEAN DECLINATION, 2001

7200 Hz COPLANAR RESISTIVITY OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, CENTRAL ALASKA

PARTS OF FAIRBANKS QUADRANGLE

2002

LOCATION INDEX



DESCRIPTIVE NOTES

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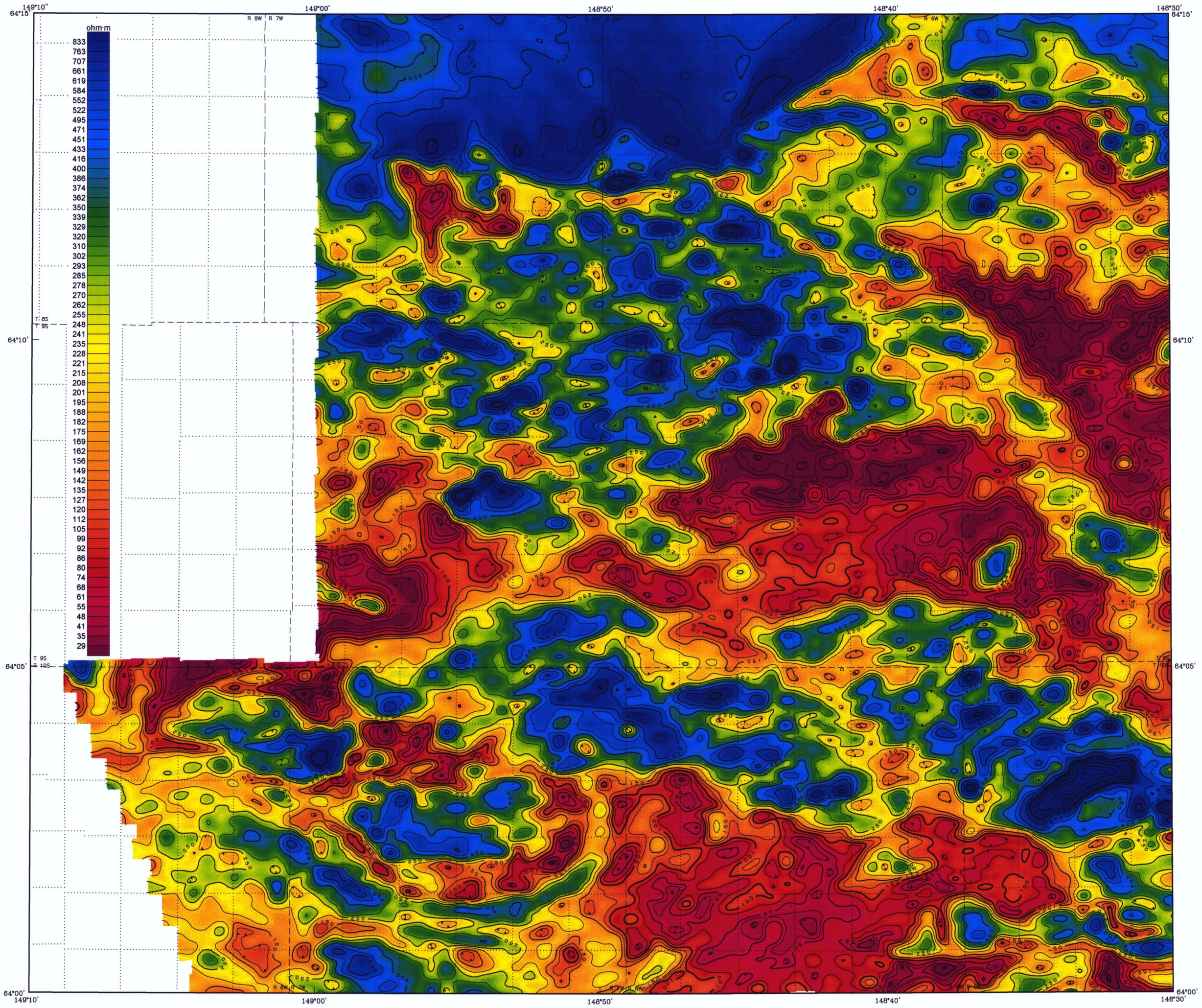
RESISTIVITY

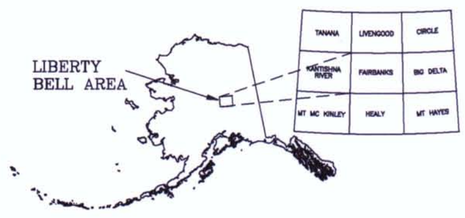
The DIGHEM^V EM system measured inphase and quadrature components at five frequencies. Two vertical coaxial–coil pairs operated at 1000 and 5500 Hz while three horizontal coplanar–coil pairs operated at 900, 7200, and 56,000 Hz. EM data were sampled at 0.1 second intervals. The EM system responds to bedrock conductors, conductive overburden, and cultural sources. Apparent resistivity is generated from the inphase and quadrature components of the coplanar 7200 Hz using the pseudo–layer half space model (Fraser 1978). The data were interpolated onto a regular 100 m grid using a modified Akima (1970) technique.

Akima, H., 1970, A new method of interpolation and smooth curve fitting based on local procedures: Journal of the Association of Computing Machinery, v. 17, no. 4, p. 589–602.

Fraser, D.C., 1978, Resistivity mapping with an airborne multicoil electromagnetic system: Geophysics, v. 43, p. 144–172.



Section outlines from U.S. Geological Survey Fairbanks A–4, 1972; Fairbanks A–5, 1984; Quadrangles, Alaska

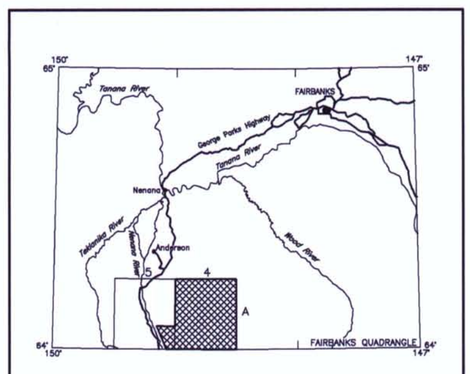


SCALE 1:63,360

1 0 1 2 3 4 MILES

1 0 1 2 3 4 5 KILOMETERS

LOCATION INDEX



7200 Hz COPLANAR RESISTIVITY OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, CENTRAL ALASKA

PARTS OF FAIRBANKS QUADRANGLE

2002

APPROXIMATE MEAN DECLINATION, 2001

DESCRIPTIVE NOTES

The geophysical data were acquired with a DIGHEM^V Electromagnetic (EM) system and a Scintrex cesium magnetometer. Both were flown at a height of 100 feet. In addition the survey recorded data from a radar altimeter, GPS navigation system, 50/60 Hz monitors and video camera. Flights were performed with an AS350B–2 Squirrel helicopter at a mean terrain clearance of 200 feet along North–South (0°) survey flight lines with a spacing of a quarter of a mile. Tie lines were flown perpendicular to the flight lines at intervals of approximately 3 miles. The blank regions indicate an area where the survey aircraft had to detour around populated areas.

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RESISTIVITY CONTOURS

1000
800
600
500
400
300
250
200
150
125
100

Contours in ohm–m at 10 intervals per decade

. . . . . resistivity low

SURVEY HISTORY

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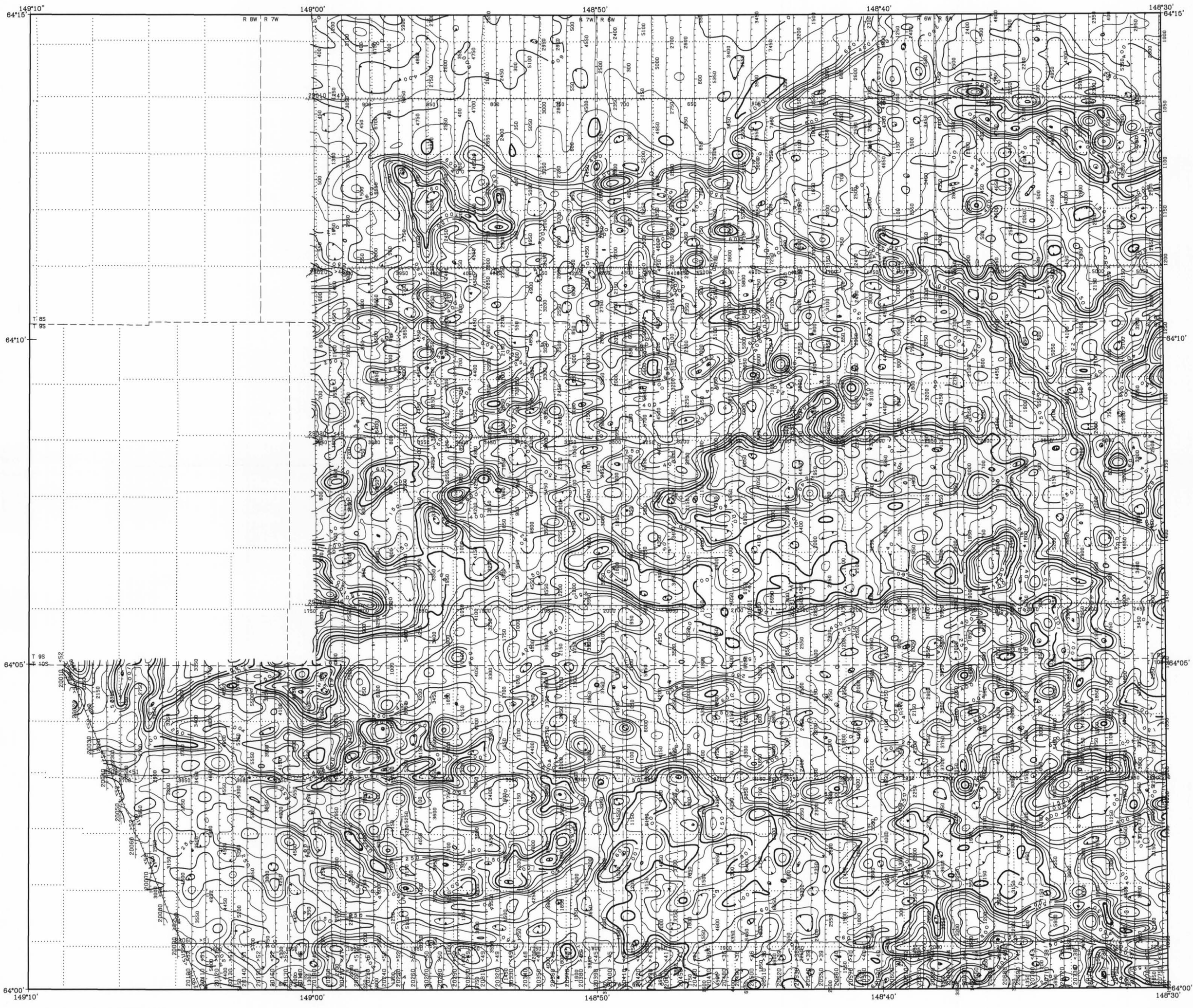

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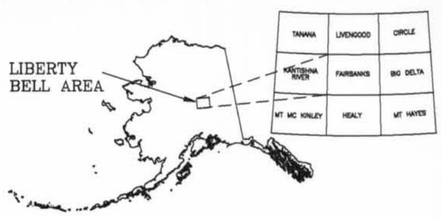
SCALE 1:63,360

1 0 1 2 3 4 MILES

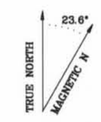
1 0 1 2 3 4 5 KILOMETERS



7200 Hz COPLANAR RESISTIVITY OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, CENTRAL ALASKA

PARTS OF FAIRBANKS QUADRANGLE

2002



APPROXIMATE MEAN DECLINATION, 2001

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RESISTIVITY CONTOURS

1000
800
600
500
400
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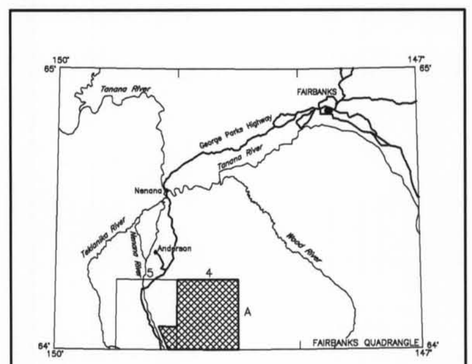
250
200
150
125
100

Contours in ohm-m at 10 intervals per decade

. . . . . resistivity low

LOCATION INDEX



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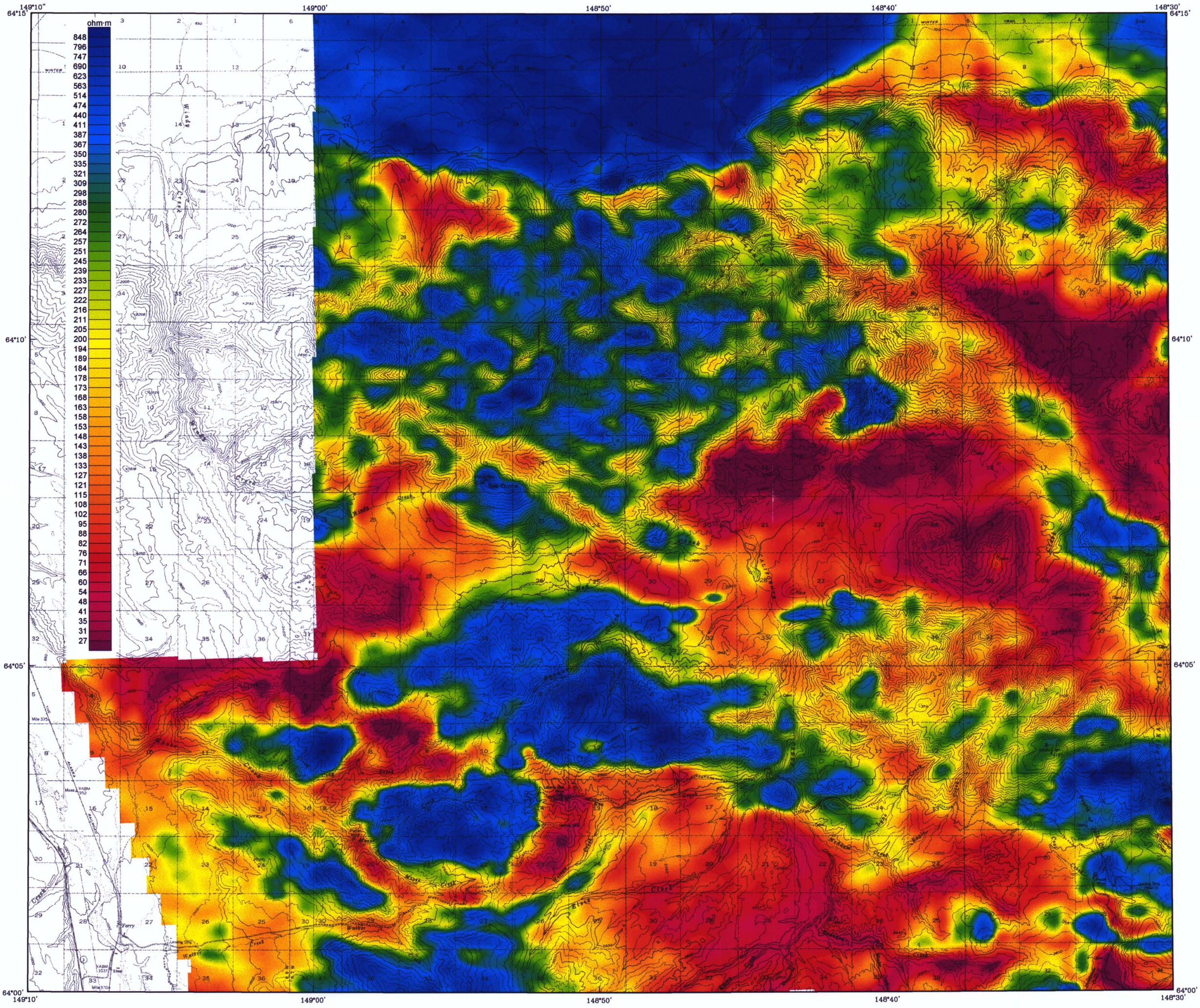


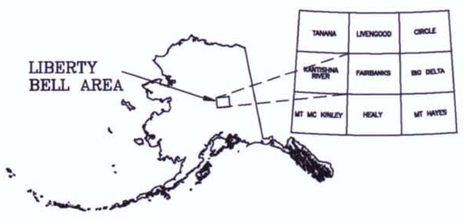
Base from U.S. Geological Survey Fairbanks A–4, 1972; Fairbanks A–5, 1964; Quadrangles, Alaska

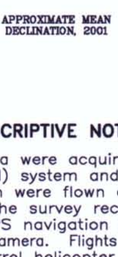
SCALE 1:63,360

1 0 1 2 3 4 MILES

1 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 100 FEET
DATUM MEAN SEA LEVEL





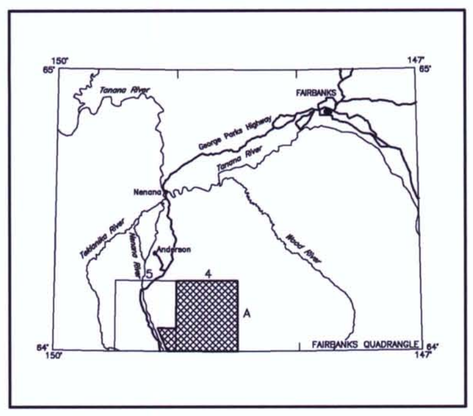
APPROXIMATE MEAN DECLINATION, 2001

900 Hz COPLANAR RESISTIVITY OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, CENTRAL ALASKA

PARTS OF FAIRBANKS QUADRANGLE

2002

LOCATION INDEX



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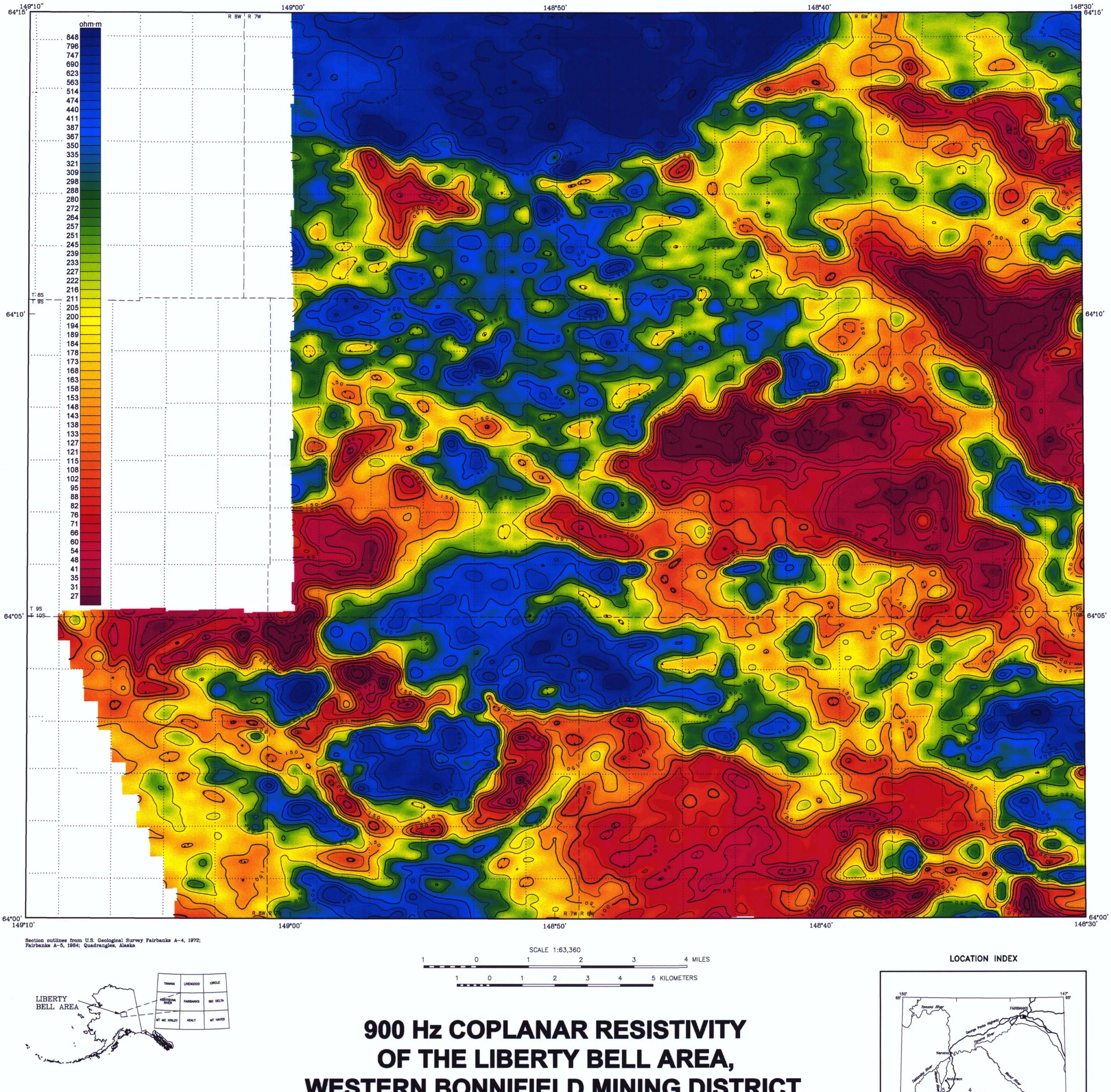

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SCALE 1:63,360

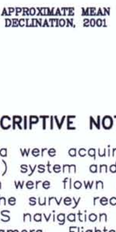
1 0 1 2 3 4 MILES

1 0 1 2 3 4 5 KILOMETERS

900 Hz COPLANAR RESISTIVITY OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, CENTRAL ALASKA

PARTS OF FAIRBANKS QUADRANGLE

2002



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RESISTIVITY CONTOURS

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Contours in ohm–m at 10 intervals per decade

. . . . . resistivity low

LOCATION INDEX

SURVEY HISTORY

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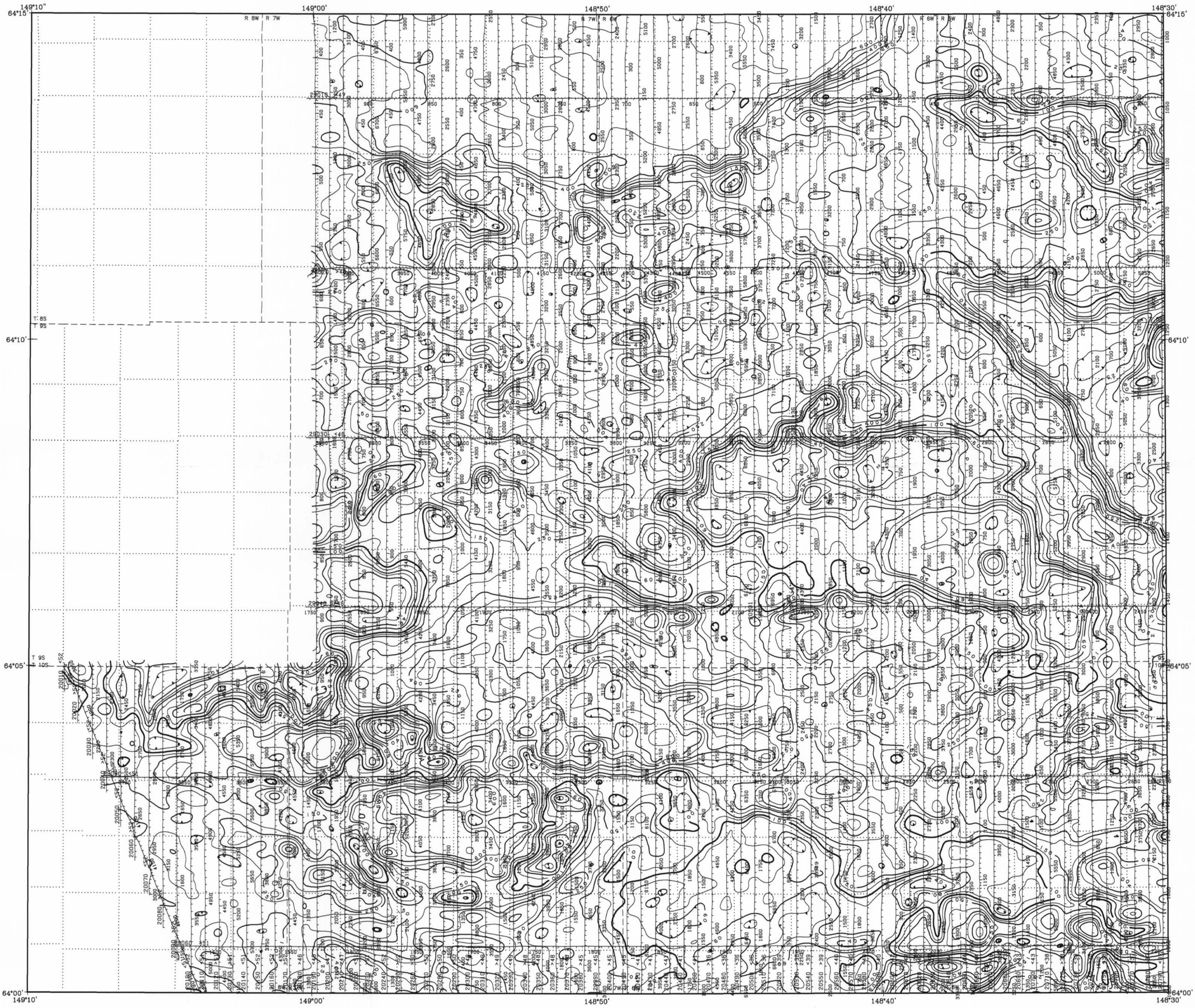

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SCALE 1:63,360

1 0 1 2 3 4 MILES

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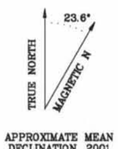

APPROXIMATE MEAN DECLINATION, 2001

900 Hz COPLANAR RESISTIVITY OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, CENTRAL ALASKA

PARTS OF FAIRBANKS QUADRANGLE

2002

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RESISTIVITY CONTOURS

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800
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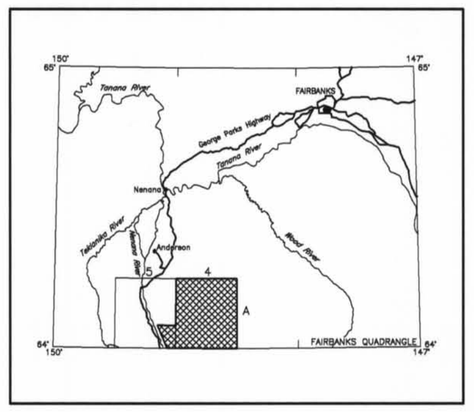
Contours in ohm-m at 10 intervals per decade

. . . . . resistivity low

LOCATION INDEX



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INTERPRETATION MAP OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, CENTRAL ALASKA

PARTS OF FAIRBANKS QUADRANGLE
2002

The interpretation is based on the geophysical parameters with reference to geological maps, which were supplied by the State of Alaska.

LEGEND

- F1 — Fault
- A1 — Conductor Axis
- M1 — Magnetic Zone
- ML1 — Magnetic Low
- RH1 — Resistive Zone
- R1 — Highly Conductive Zone

149°10' 149°00' 148°50' 148°40' 148°30'
64°15' 64°10' 64°05' 64°00'
R 8W R 7W R 6W R 5W
T 8S T 9S T 10S

SCALE 1:63,360

1 0 1 2 3 4 MILES

1 0 1 2 3 4 5 KILOMETERS