Division of Geological & Geophysical Surveys

# GEOPHYSICAL REPORT 2002_10

# PORTFOLIO OF AEROMAGNETIC AND RESISTIVITY MAPS OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, ALASKA

by

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# PORTFOLIO OF AEROMAGNETIC AND RESISTIVITY MAPS OF THE LIBERTY BELL AREA, WESTERN BONNIFIELD MINING DISTRICT, ALASKA

In the summer of 2001, the Alaska Division of Geologic & Geophysical Surveys acquired airborne geophysical data over 276 square miles in the Fairbanks (figure 1). The data were acquired and processed under contract by Stevens Exploration Management, Corp. and their subcontractor, Fugro Airborne Surveys. Aeromagnetic and electromagnetic data were collected in August of 2001 and were released March 2002 in the forms of maps and digital files.

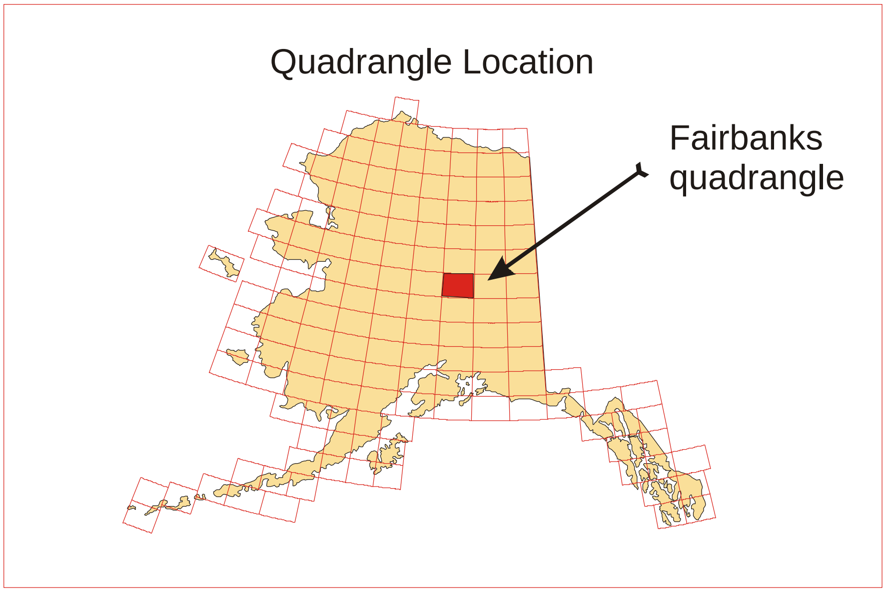


**Figure 1.** Location of Fairbanks quadrangle.

This Geophysical Report (GPR) contains generalized information on data acquisition, data interpretation, publications, and data formats available for the Liberty Bell geophysical survey. Page-size color maps of most of the data are also included. The contractor's report, GPR 2002_9, gives a more detailed interpretation of the data and a more complete description of the processing.

The acetate topography included with this portfolio should be used only for generalized locations. For accurate locations, the large scale geophysical maps or the computer files should be used. The area surveyed in 2001 includes all of the Fairbanks A-4 and part of the A-5 quadrangles.

Clients can request maps from this geophysical survey from the Alaska Division of Geological & Geophysical Surveys. Ordering information and available maps are listed at the end of this portfolio. Some of the products are available at DNR's Public Information Center in Anchorage. Most of the maps in this portfolio are available from DGGS. Custom plots of variations of the data can be made at any scale at the DGGS office for a reasonable fee.

**PRODUCTS AVAILABLE FROM THIS SURVEY**

Maps are available of the aeromagnetic, 7200 Hz coplanar resistivity data, and 900 Hz coplanar resistivity data. Most of the maps for the Liberty Bell area were produced at 1:63,360 scale (1 inch = 1 mile, fig. 2). Aeromagnetic maps with electromagnetic (EM) anomalies were produced at 1:63,360-scale with simplified EM symbols and 1:31,680-scale (1 inch = ½ mile; fig. 3) with detailed EM symbols (1 inch = ½ mile; fig. 3).

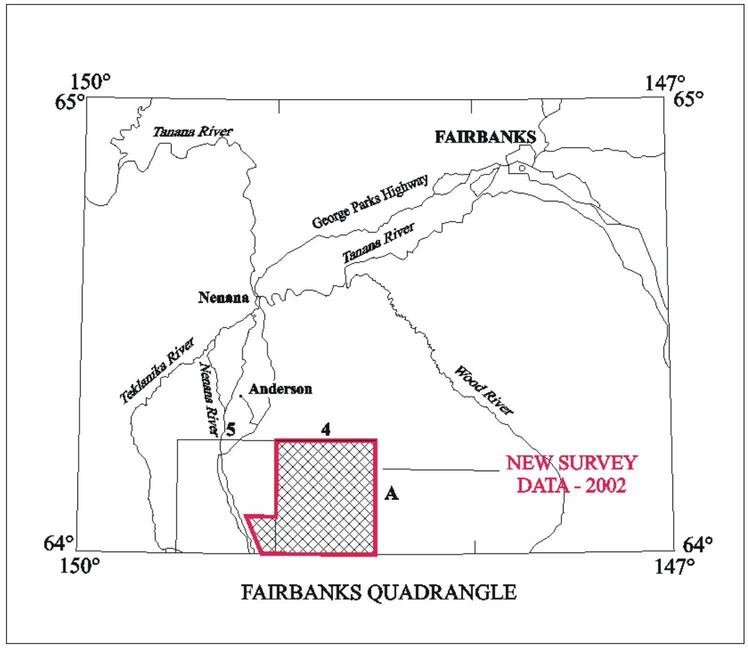


**Figure 2.** Index map showing area of new data acquisition (red outline). All 63,360-scale maps fit on one sheet.

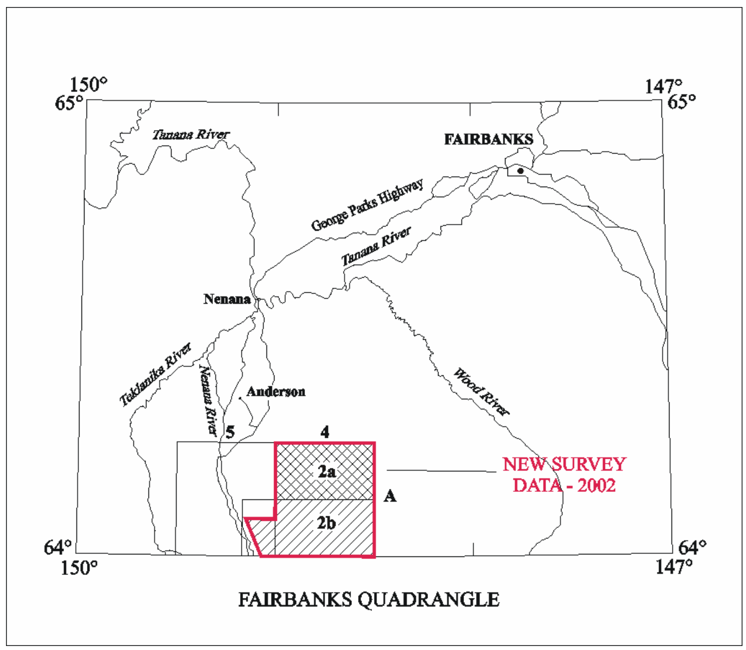


**Figure 3.** Index map for aeromagnetic maps available at 1:31,680 (1 inch = ½ mile) scale. Only aeromagnetic maps with detailed EM anomalies are available at this scale. Two map sheets (marked 2a and 2b) are used to cover the area at 31,680-scale.

Three CD-ROMS were produced for this survey. GPR 2002_6 contains plot files in HPGL/2 format of the 13 maps produced from this survey. The plot files were produced with Hewlett Packard Designjet 2500 printer driver version 4.61. GPR 2002_7 contains the processed line data, gridded data (magnetic data, 900 Hz, 7200 Hz, and 56,000 Hz coplanar apparent resistivity data, and a digital terrain model), data contour files, and detailed electromagnetic anomalies. The processed line data is in Geosoft Ascii format, the gridded data are in both Geosoft Ascii and Geosoft binary format, and the vector files are in Autocad version 14 dxf files. GPR 2002_8 contains the gridded data (in Geosoft binary format only), data contour files, and detailed electromagnetic anomalies.

**Survey history, instrumentation, & data processing**

The following indented section describing the instrumentation and processing is modified from the metadata included on the CD-ROMS.

> The 2002 airborne 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 NW-SE (340 degrees) survey flight lines with a spacing of one quarter mile. Tie lines were flown perpendicular to the flight lines at intervals of approximately 3 miles.

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 meridian (CM) of 147 degrees, a north constant of 0 and an east constant of 500,000.

### Total Field Magnetics:

The total magnetic field data were acquired with a sampling interval of 0.1 seconds, and 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 aeromagnetic data are interpolated onto a regular 100 m grid using a modified Akima (1970) technique.

### Resistivity:

The EM inphase and quadrature data are drift corrected using base level data collected at high altitude (areas of no signal). Along-line filters are applied to the data to remove spheric spikes. The data are inspected for variations in phase, and a phase correction is applied to the data if necessary. Resistivities are then calculated from the inphase and quadrature data for all frequencies based on a pseudo-layer half-space model. Manual leveling of the inphase and quadrature of each coil pair, based on the resistivity data and comparisons to the data from the other frequencies, is performed. Automated micro-leveling is carried out in areas of low signal. The resistivity data are then interpolated onto a regular 100 m grid using a modified Akima (1970) technique. The resulting grids are subjected to a 3x3 hanning filter before contouring and map production.

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.

## Generalized information about aeromagnetic, electromagnetic, and radiometric data

### Magnetic data

The magnetometer is a passive instrument that measures the earth’s magnetic field in nanoTeslas (nT). Rocks with high magnetic susceptibilities (measured in SI units) locally attenuate or dampen these magnetic signals producing the relative highs and lows. Iron-rich magnetic minerals such as magnetite, ilmenite, and pyrrhotite have the highest magnetic susceptibility. These minerals commonly occur in mafic volcanic rocks (such as basalt), mafic and ultramafic plutonic rocks (such as serpentinite, clinopyroxenite, and gabbro), some skarns, and in some other geologic units. Rocks with low to no iron tend to produce little variation in the magnetic signal. These include silicic volcanic rocks (rhyolites), silicic plutonic rocks (granites), and most sedimentary rocks (for example, limestone, sandstone, and shale). Some iron rich minerals – such as pyrite – are not magnetic and do not produce a magnetic signal.

Different types of ore deposits have different magnetic signatures. A bedrock gold deposit associated with the top of a granitic pluton would likely be an aeromagnetic low whereas a magnetite-bearing gold skarn would be an aeromagnetic high. A gold deposit hosted by a low-angle (thrust) fault has a different signature than one hosted by a high-angle fault.

Figures 4a and 4b show the aeromagnetic data for the survey area. The high values (in nT) are purple and orange and indicate appreciably magnetic rocks. The low values are the blues and greens. A gradual change in color indicates a gradual change in the magnetic field strength. This can be caused by either a gradual change in magnetic susceptibility of rocks near the surface, the gradual burial of a rock unit of relatively constant magnetic susceptibility, or the introduction of a new unit at depth. Conversely, an abrupt change in color indicates an abrupt change in the magnetic susceptibility. This is caused by juxtaposing two rock units with very different magnetic susceptibilities such as is the case with faults, volcanic dikes, or some mineralized zones. Faults can be inferred on aeromagnetic maps from linear or curvilinear features composed of discontinuous aeromagnetic highs or lows.

Figure 4b shows the aeromagnetic data presented as “color shadow” maps where a simulated light source is shown on the three-dimensional data. The higher values appear bright like mountaintops struck by sunlight. The light source can be rotated in a complete circle with 0° (north) clockwise to 180° (south) and back to 360° (north). Shadow maps can enhance structures, such as faults, intrusions, and the trend of stratigraphic layers

## Resistivity data

The electromagnetic (EM) system is an active instrument that measures the resistivity of the rocks below it by sending out electromagnetic signals at different frequencies and recording the signals that are returned from the earth. The high values (measured in ohm-m) are indicative of resistive (low conductivity) rocks, such as quartzite. Low resistivity (high conductivity) values are present for bedrock conductors (water-saturated clays, graphite, concentrations of certain sulfides, some alteration halos), conductive overburden (water-saturated zones), and cultural sources (e.g. powerlines). The main conductive minerals are graphite, most sulfides, (but not sphalerite), and water-saturated clays. Rocks hydrothermally altered to clay minerals also are conductive. Some faults will show up very well on the resistivity maps, because they either offer a conduit for ground water or they separate rocks with markedly different resistivities.

The EM instrument (bird) contains 5 or more transmitting coils in front and 5 matching (paired) receiver coils in the rear. Three of these pairs are coplanar – the axes of the coils are perpendicular to the long axis of the bird. Two of these pairs are coaxial – the axes of the coils are parallel to the long axis of the bird. These two major geometric configurations, coplanar and coaxial, record different information about the conductivity of the rocks below. Coplanar coils emphasize horizontal and flat lying conductive units. Coaxial coils emphasize vertical to near vertical conductive units.

The coplanar resistivity data are shown in Figures 5-7. The resistivity maps are produced from the EM coplanar coil pairs, and emphasize horizontal or near horizontal units and structures. Since ground penetration correlates inversely with frequency, the 56,000 Hz reflects very near surface rocks and the 900 Hz adds the influence of deeper rocks in general. The 7200 Hz in general reflects rocks between the two extremes. However, the depth of penetration is variable depending on the resistivity of the rocks the signal is passing through.

EM anomalies are shown with both the 1:63,360 and 1:31,680 scale magnetic maps. EM anomalies are derived from the coaxial coil pairs, which emphasize vertically- or near-vertically-dipping “discrete” bedrock conductors. These EM anomalies are shown as circular symbols along flight lines with the aeromagnetic contours. On the 1:63,360 scale maps, anomalies are subdivided into those with 1) a signal strength greater than 50 siemens, 2) a signal strength less than 50 siemens, and 3) weak conductivity associated with an EM magnetite response. Questionable (or possible) anomalies are also noted.

More detailed interpretations for the electromagnetic anomalies are shown on the 1:31,680 scale aeromagnetic maps. In these maps, the EM anomaly is shown as a symbol that denotes more information about signal strength and the anomaly source than on the 1:63,360 maps. Instead of two signal strengths (greater than or less than 50 siemens) shown on the 1:63,360 maps, signal strength on the 1:31,680 maps is broken into seven subdivisions (e.g. 5-10 siemens, 1-5 siemens, etc). In addition, potential sources shown for each symbol include 1) bedrock conductors, 2) narrow bedrock conductors ("thin dike"), 3) conductive covers ("horizontal thin sheet"), 4) combination including broad conductive rock units, deep conductive weathering, and thick conductive cover, 5) edge of broad conductor, and 6) culture. This information is also available on the CD-ROMS. The project report, GPR 2002-9, gives a more detailed discussion of these EM anomalies.

## DGGS PUBLICATIONS PRODUCED FOR THE LIBERTY BELL AREA

Bold font is used below to highlight the differences between the maps.

### AEROMAGNETIC MAPS

**GPR 2002_6_1a. Total magnetic field** of the Liberty Bell area, western Bonnifield mining district, Alaska, 1 sheet, **scale 1:63,360. Topography included. Full-color plot** from electronic file, 600 dpi.

**GPR 2002_6_1b. Total magnetic field** of the Liberty Bell area, western Bonnifield mining district, Alaska, 1 sheet, **scale 1:63,360. Magnetic contours and section lines included. Full-color plot** from electronic file, 600 dpi.

**GPR 2002_6_1c. Color shadow magnetic map** of the Liberty Bell area, western Bonnifield mining district, Alaska, 1 sheet, **scale 1:63,360. Full-color plot** from electronic file, 600 dpi.

**GPR 2002_6_1d. Total magnetic field and electromagnetic anomalies** of the Liberty Bell area, western Bonnifield mining district, Alaska, 1 sheet, **scale 1:63,360. Magnetic contours, simplified electromagnetic anomalies, and section lines included**. **Black and white plot** from electronic file, 600 dpi**.**

**GPR 2002_6_2a. Total magnetic field and detailed electromagnetic anomalies** of the Liberty Bell area, western Bonnifield mining district, Alaska, 1 sheet**, scale 1:31,680** (**northern half of Fairbanks A-4 quadrangle**). **Magnetic contours, detailed electromagnetic anomalies, and topography included. Black and white plot** from electronic file, 600 dpi**.**

**GPR 2002_6_2b. Total magnetic field and detailed electromagnetic anomalies** of the Liberty Bell area, western Bonnifield mining district, Alaska, 1 sheet, **scale 1:31,680 (southern half of Fairbanks A-4 and part of the southeast Fairbanks A-5 quadrangles**). **Magnetic contours, detailed electromagnetic anomalies, and topography included. Black and white plot** from electronic file, 600 dpi**.**

### RESISTIVITY MAPS

**GPR 2002_6_3a. 7200 Hz coplanar resistivity** of the Liberty Bell area, western Bonnifield mining district, Alaska, 1 sheet, **scale 1:63,360. Topography included. Full-color plot** from electronic file, 600 dpi.

**GPR 2002_6_3b. 7200 Hz coplanar resistivity** of the Liberty Bell area, western Bonnifield mining district, Alaska, 1 sheet, **scale 1:63,360. Resistivity contours and section lines included**. **Full-color plot** from electronic file, 600 dpi.

**GPR 2002_6_3c. 7200 Hz coplanar resistivity** of the Liberty Bell area, western Bonnifield mining district, Alaska, 1 sheet, **scale 1:63,360. Resistivity contours and section lines included. Black and white plot** from electronic file, 600 dpi.

**GPR 2002_6_4a. 900 Hz coplanar resistivity** of the Liberty Bell area, western Bonnifield mining district, Alaska, 1 sheet, **scale 1:63,360. Topography included. Full-color plot** from electronic file, 600 dpi.

**GPR 2002_6_4b. 900 Hz coplanar resistivity** of the Liberty Bell area, western Bonnifield mining district, Alaska, 1 sheet, **scale 1:63,360. Resistivity contours and section lines included**. **Full-color plot** from electronic file, 600 dpi.

**GPR 2002_6_4c. 900 Hz coplanar resistivity** of the Liberty Bell area, western Bonnifield mining district, Alaska, 1 sheet, **scale 1:63,360. Resistivity contours and section lines included. Black and white plot** from electronic file, 600 dpi**.**

### DIGITAL FILES, PROJECT REPORT, PORTFOLIO, AND FLIGHT LINES

**GPR 2002_6_5a. Flight lines** of the Liberty Bell area, western Bonnifield mining district, Alaska, 1 sheet, **scale 1:63,360. Topography included. Black and white plot** from electronic file, 600 dpi**.**

**GPR 2002_6. Plot files** of the airborne geophysical survey data of the Liberty Bell area, western Bonnifield mining district, Alaska. **1 CD-ROM set**. **Contains 13 maps** listed below as GPR2002_6_xy in **prn printer file format** made with an **HP Designjet 2500 HPGL/2 printer driver v4.61. Check for printer compatability.**

**GPR 2002_7. Line, gridded, and vector data** of airborne geophysical survey data for the Liberty Bell area, western Bonnifield mining district, Alaska. **2 CD-ROM set. Line data in ASCII format; gridded data in Geosoft format; vector files in Autocad 14 dxf files.**

**GPR 2002_8. Gridded and vector data** of airborne geophysical survey data for the Liberty Bell area, western Bonnifield mining district, Alaska. **1 CD-ROM set. Gridded data in Geosoft format; vector files in Autocad 14 dxf files.**

**GPR 2002_9. Project report of the airborne geophysical survey** of the Liberty Bell area, western Bonnifield mining district, Alaska, by Ruth Pritchard, Fugro Airborne Surveys, 2002, scale 1:63,360.

**GPR 2002_10. Portfolio of aeromagnetic and resistivity maps** of the Liberty Bell area, western Bonnifield mining district, Alaska**. Includes color and shadow maps. Maps fit 8½” x 11” sheet.**

## SELECTED REFERENCES FOR THE LIBERTY BELL AREA

Online links current at the time of this publication are provided when known. DGGS data on the web is either in PDF format (reports) or Mr. SID format (maps). The Mr. Sid format maps will probably be replaced by Adobe Acrobat formats in the future. Note that these web sites are current at the time of publication, and may change slightly in the future. In that case, the DGGS publications will still be able to be reached through the DGGS website (http://wwwdggs.dnr.state.ak.us/).

**GEOPHYSICAL DATA**

Alaska Geologic Survey, 1973, Aeromagnetic map, Fairbanks Quadrangle: Alaska Division of Geological & Geophysical Surveys, Alaska Open File Report 8:
http://wwwdggs.dnr.state.ak.us/scan1/aof/text/AOF008.PDF Report, 5 p., 146 KB.
http://wwwdggs.dnr.state.ak.us/scan1/aof/oversized/AOF008-SH1.SID Map, scale 1:250,000, 2036 KB.

Barnes, David F., 1977, Preliminary Bouguer gravity map of Alaska, U.S. Geological Survey Open-File Report, 77-0168-C.

Saltus, R.W., and Simmons, G.C., 1997, Composite and Merged Aeromagnetic Data for Alaska: A Website for Distribution of Gridded Data and Plot Files: U.S. Geological Survey Open File Report OFR 97-520.
http://greenwood.cr.usgs.gov/pub/open-file-reports/ofr-97-0520/alaskamag.html

**GEOLOGIC DATA**

Albanese, M.D., 1981, Two Holocene maars in the Alaska Range: in Short Notes on Alaskan Geology - 1981: Alaska Division of Geological & Geophysical Surveys, Geologic Report 73E:
http://wwwdggs.dnr.state.ak.us/scan1/gr/text/GR73.PDF 62 p., 2710 KB.

Bundtzen, T.K., Gilbert, W.G., 1977, Reconnaissance geochemistry of parts of the Fairbanks A-4 and Healy D-2, D-3 and D-4 Quadrangles: Alaska Division of Geological & Geophysical Surveys, Alaska Open File Report 108:
http://wwwdggs.dnr.state.ak.us/scan1/aof/text/AOF108.PDF 10 p., 320 KB.
http://wwwdggs.dnr.state.ak.us/scan1/aof/oversized/AOF108-SH1.SID Plate 1, scale 1;125,000, 2339 KB.

Freeman, Curtis J., and Schaefer, Janet, 2001, The Alaska Resource Data Files, Fairbanks Quadrangle, U.S. Geological Survey Open-File Report 01-354. http://ardf.wr.usgs.gov/quads/html/Fairbanks.html

Merritt, R.D., 1986, Geology and coal resources of the Wood River Field, Nenana Basin: Alaska Division of Geological & Geophysical Surveys, Public Data File 86-68:
http://wwwdggs.dnr.state.ak.us/scan2/pdf86/text/PDF86-68.PDF 37 p., 788 KB.

Merritt, R.D., 1986, Coal geology and resources of the Nenana Basin, Alaska: Alaska Division of Geological & Geophysical Surveys, Public Data File 86-74:
http://wwwdggs.dnr.state.ak.us/scan2/pdf86/text/PDF86-74.PDF 70 p., 1248 KB.

Pilgrim, E.R., 1931, Gold lodes of the Nenana District: Alaska Territorial Department of Mines, Miscellaneous Report 58-03:
http://wwwdggs.dnr.state.ak.us/scan1/mr/text/MR058-03.PDF 11 p., 577 KB.

Rawlinson, S.E., 1987, Preliminary photointerpretive maps of the geology, geologic materials, permafrost, and wetlands classification of the Fairbanks B-5 Quadrangle, Alaska, 1987: Alaska Division of Geological & Geophysical Surveys, Public Data File 87-17:
http://wwwdggs.dnr.state.ak.us/scan2/pdf87/text/PDF87-17.PDF 25 p., 396 KB.
http://wwwdggs.dnr.state.ak.us/scan2/pdf87/oversized/PDF87-17-SH1.SID Sheet 1, Preliminary photointerpretive geologic map of the Fairbanks B-5 Quadrangle, Alaska, scale 1:31,680, 5078 KB.
http://wwwdggs.dnr.state.ak.us/scan2/pdf87/oversized/PDF87-17-SH2.SID Sheet 2, Preliminary photointerpretive geologic-materials map of the Fairbanks B-5 Quadrangle, Alaska, scale 1:31,680, 5613 KB.
http://wwwdggs.dnr.state.ak.us/scan2/pdf87/oversized/PDF87-17-SH3.SID Sheet 3, Preliminary photointerpretive permafrost map of the Fairbanks B-5 Quadrangle, Alaska, scale 1:31,680, 5622 KB.
http://wwwdggs.dnr.state.ak.us/scan2/pdf87/oversized/PDF87-17-SH4.SID Sheet 4, Preliminary photointerpretive wetlands-classification map of the Fairbanks B-5 Quadrangle, Alaska, scale 1;31,680, 5175 KB.

Swainbank, R.C., Robinson, M.S., and Clement, R.F., 1992, Map of selected mines, reserves, and resources in Alaska: Alaska Division of Geological & Geophysical Surveys, Public-data File 92-16, 1 plate, scale 1:2,500,000.

Szumigala, D.J., 1999, Map of prospective mineral areas and significant mineral resources of Alaska: Alaska Division of Geological & Geophysical Surveys Miscellaneous Publication 38, 1 sheet, scale 1:2,500,000.

Szumigala, D.J., and Swainbank, R.C., 1998, Map of selected mines, coalfields, and significant mineral resources of Alaska: Alaska Division of Geological & Geophysical Surveys Miscellaneous Publication 33, 1 sheet, scale 1:250,000.

Wahrhaftig, Clyde, 1970, Geologic map of the Fairbanks A-4 quadrangle, Alaska, U.S. Geological Survey Geologic Quadrangle Map GQ-810, scale 1:63,360

Wahrhaftig, Clyde, 1970, Geologic map of the Fairbanks A-5 quadrangle, Alaska, U.S. Geological Survey Geologic Quadrangle Map GQ-811, scale 1:63,360

Wilson, Frederic H., Dover, James H. , Bradley, Dwight C. , Weber, Florence R., Bundtzen, Thomas K. , and J. Haeussler. Peter J., 1998, Geologic Map of (Interior) Alaska: U.S. Geological Survey Open-File Report OF 98-133-A. http://wrgis.wr.usgs.gov/open-file/of98-133-a/

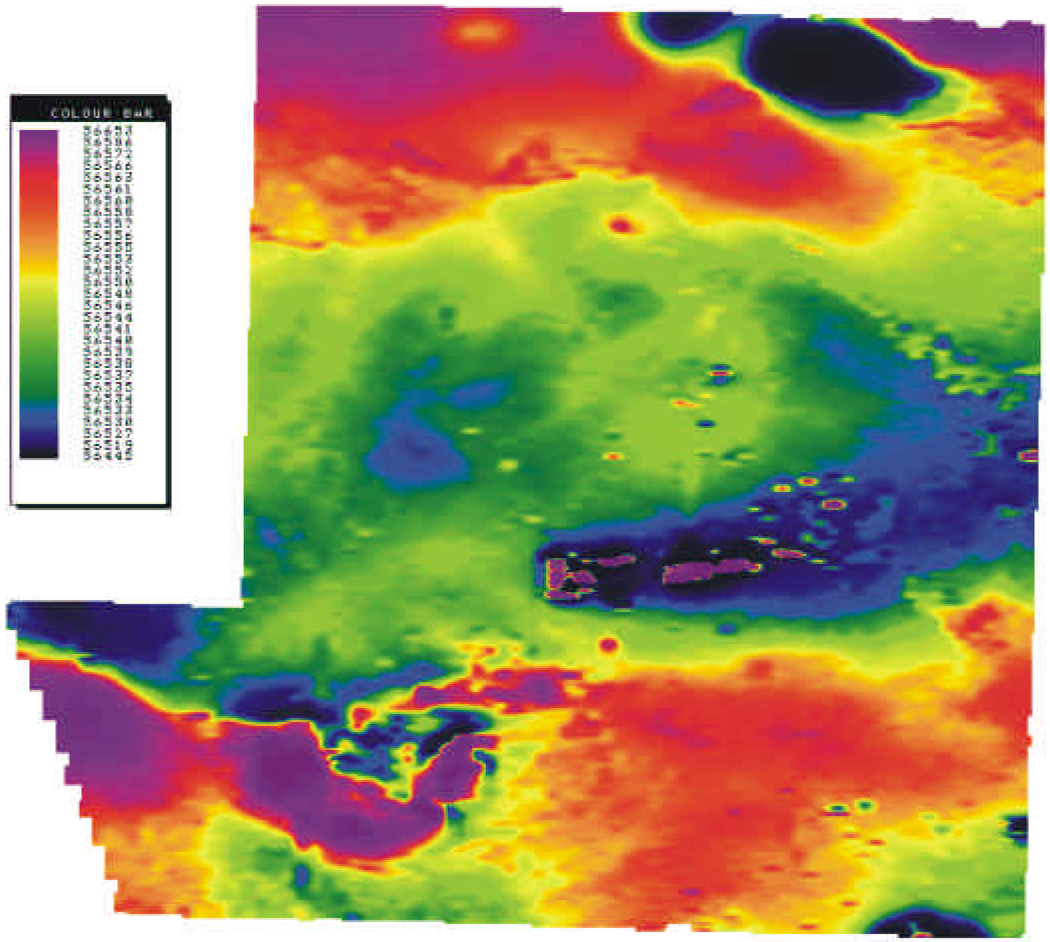


Figure 4a. Total field magnetics of the Liberty Bell area, western Bonnifield mining district. Magnetic units are in nT.

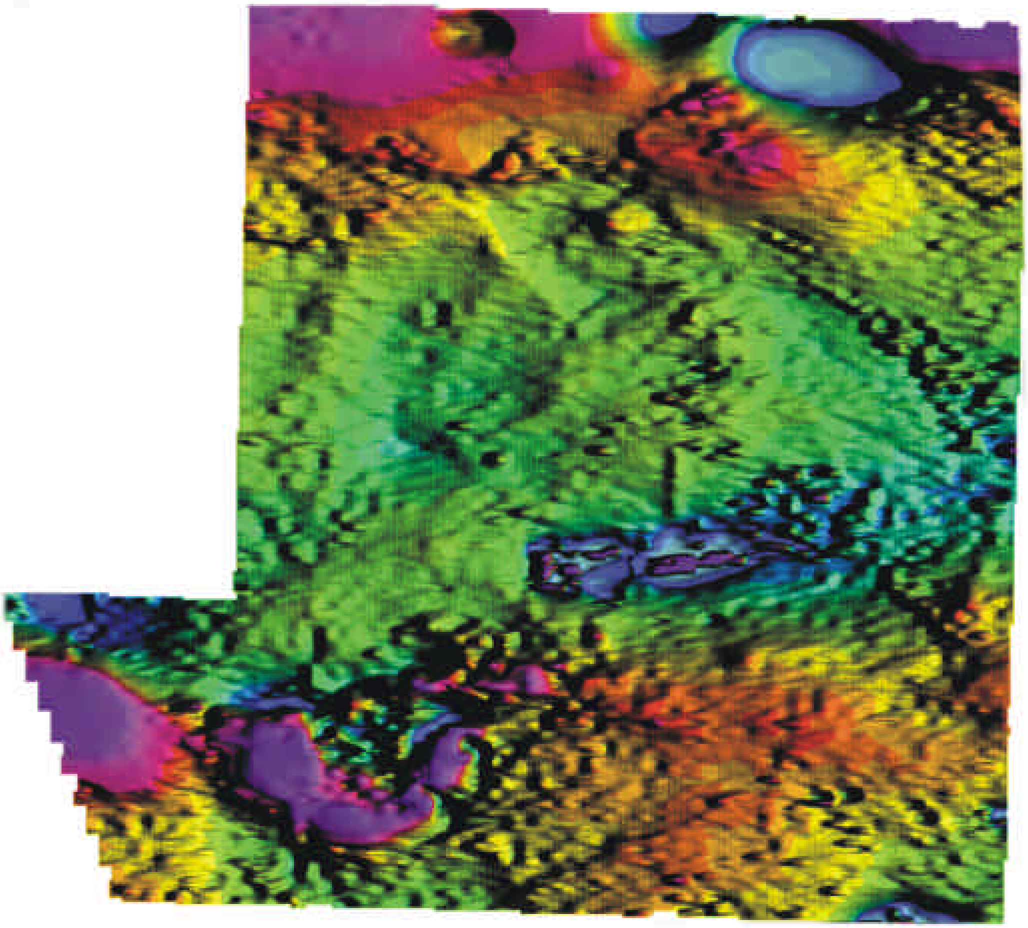

Figure 4b. Color shadow map of the total field magnetics of the Liberty Bell area, western Bonnifield mining district. Illumination is from ENE. Magnetic units are in nT.

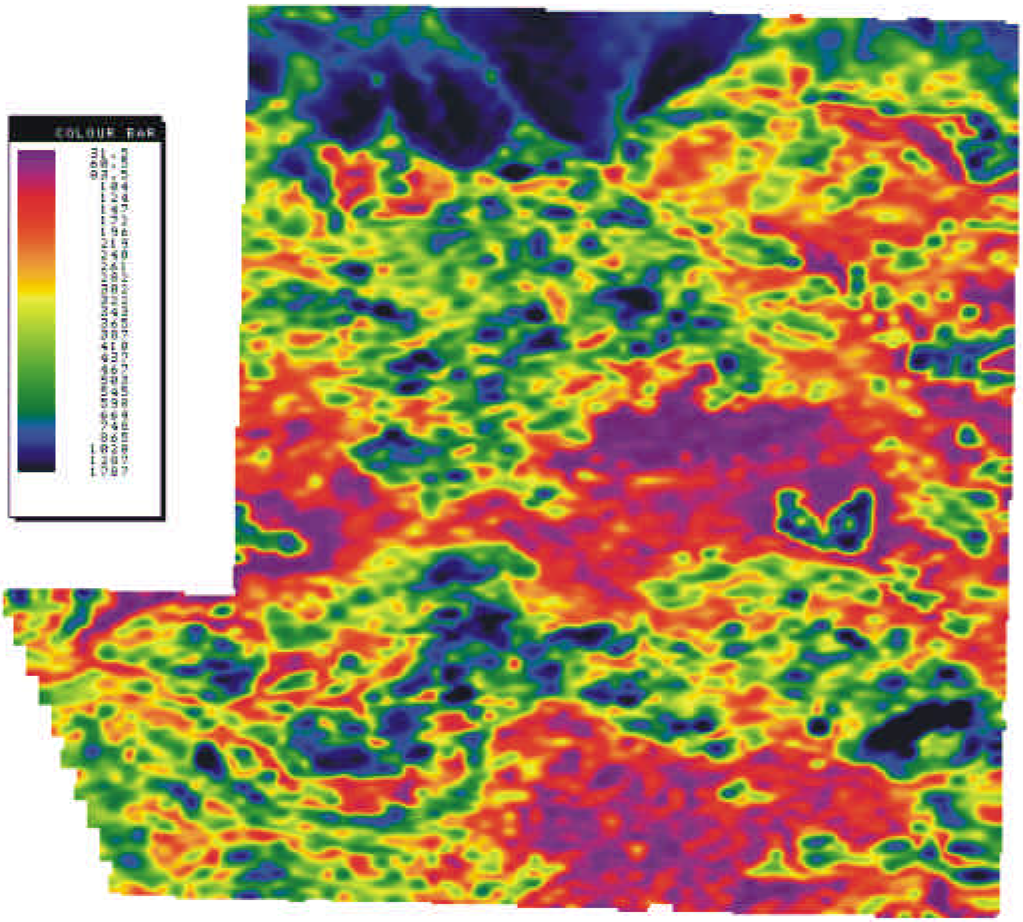


Figure 5. 56,000 Hz coplanar resistivity of the Liberty Bell area, western Bonnifield mining district. Resistivity units in ohm-m. Conductive units have low numbers and are shown in purple and orange on this map.

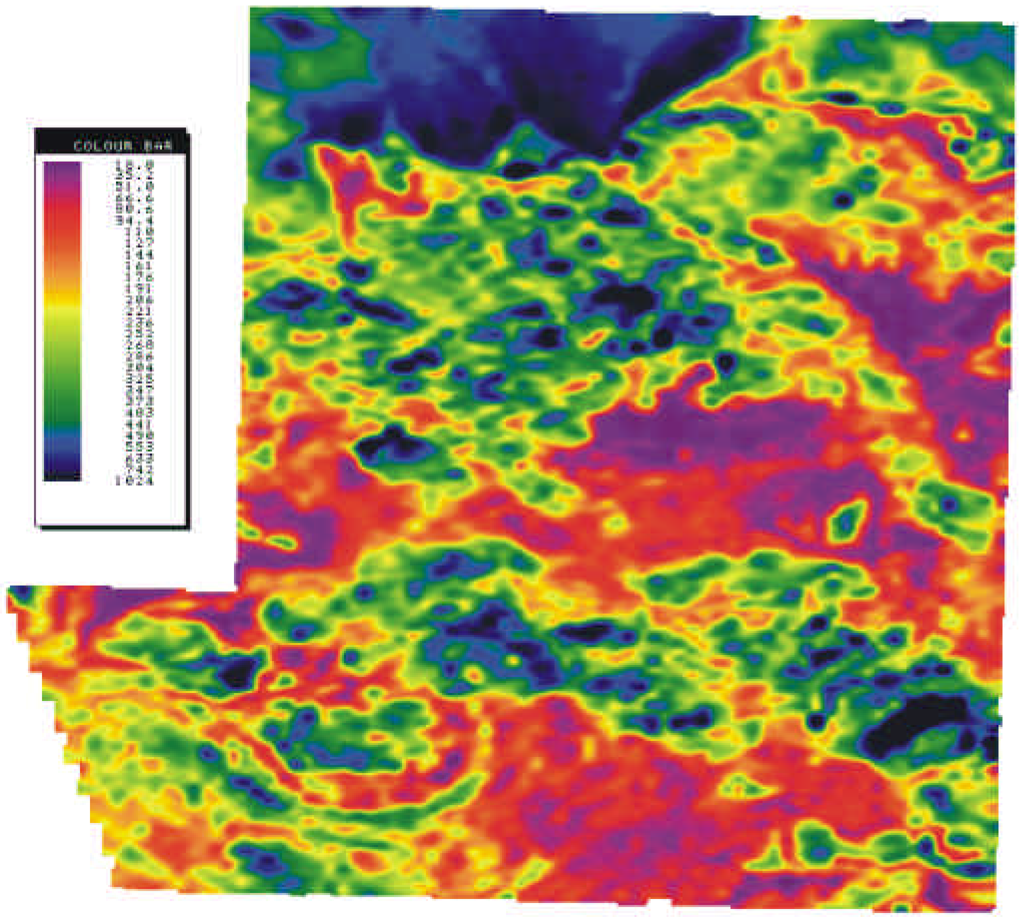


Figure 6. 7,200 Hz coplanar resistivity of the Liberty Bell area, western Bonnifield mining district. Resistivity units in ohm-m. Conductive units have low numbers and are shown in purple and orange on this map.

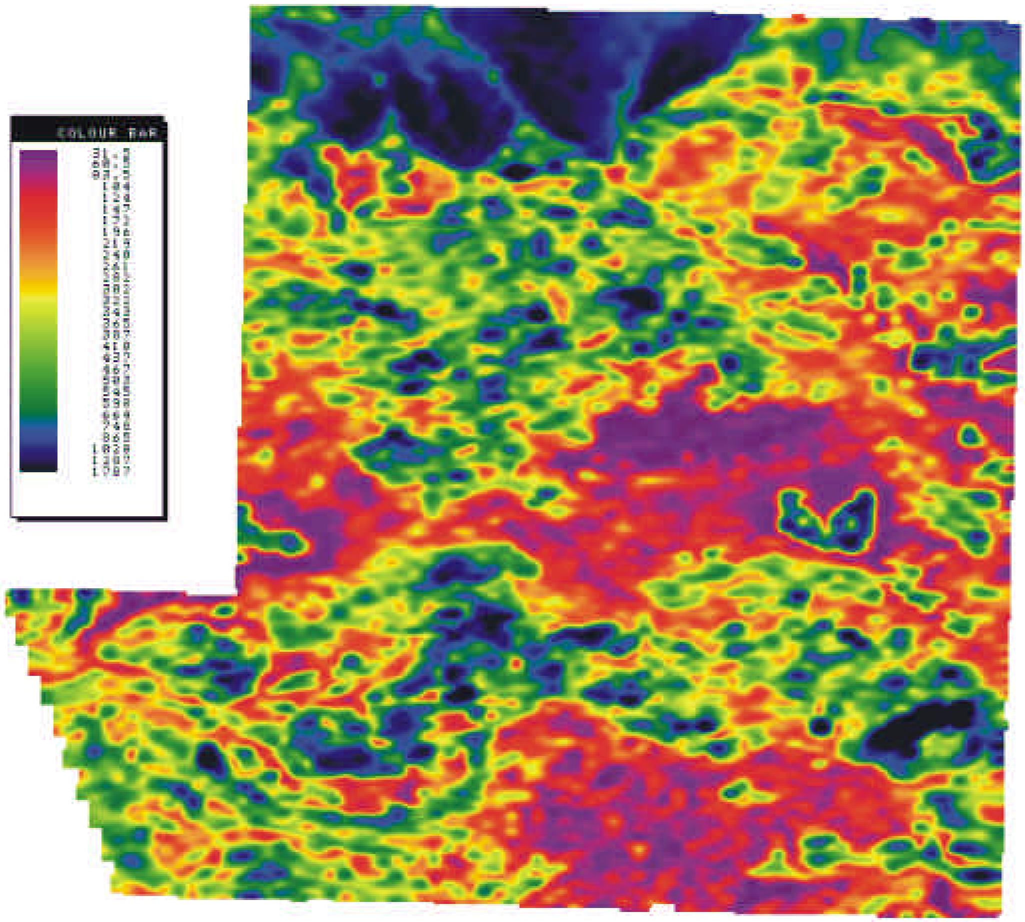

Figure 7. 900 Hz coplanar resistivity of the Liberty Bell area, western Bonnifield mining district. Resistivity units in ohm-m. Conductive units have low numbers and are shown in purple and orange on this map.

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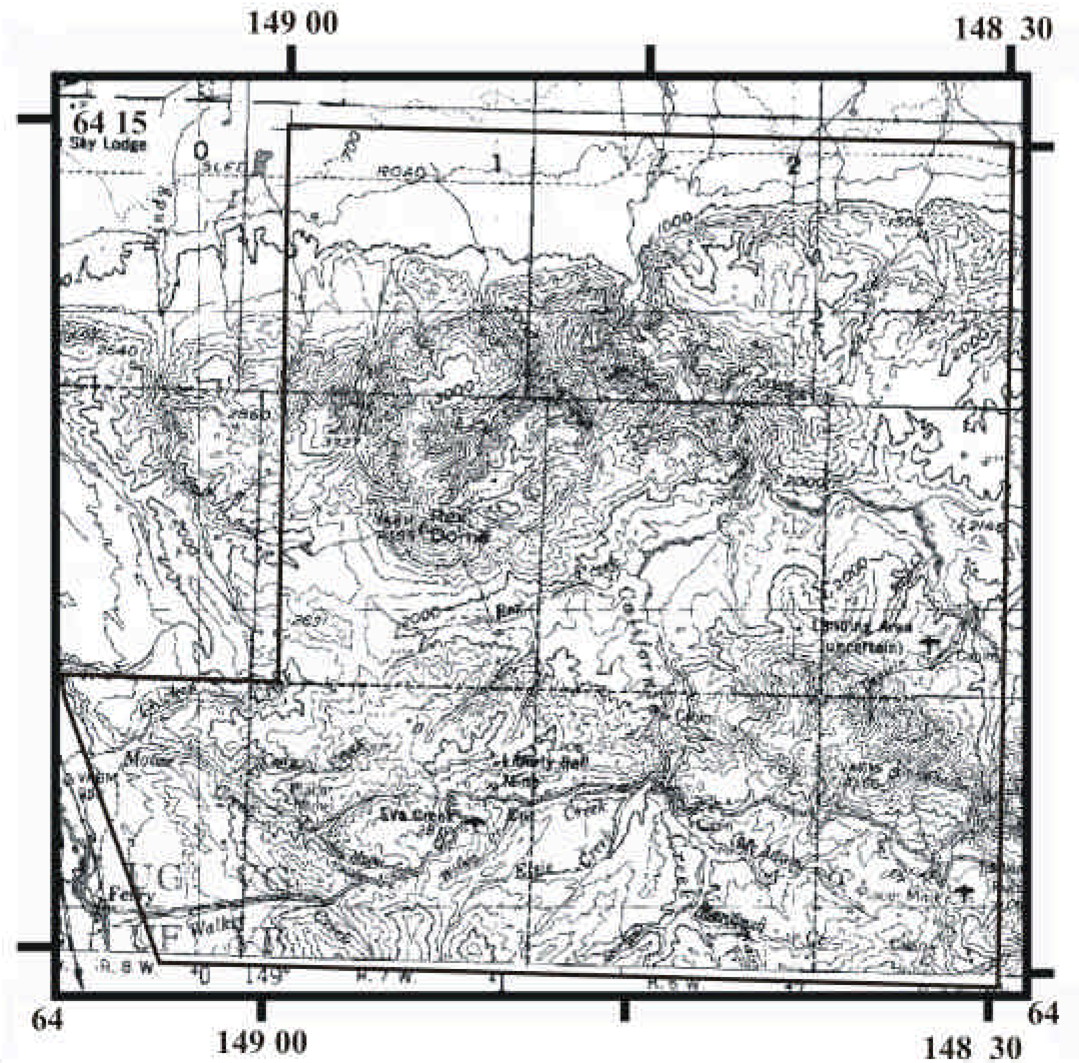


Topography for GPR 2002_10. Outlined area shows the general location for the Liberty Bell survey, western Bonnifield mining district. This topography should only be used for generalized location.