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PORTFOLIO OF AEROMAGNETIC AND RESISTIVITY MAPS OF THE CHULITNA MINING DISTRICT

by

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Portfolio of aeromagnetic and resistivity maps of the Chulitna mining district, Alaska.

This portfolio contains page-size illustrations of aeromagnetic and electromagnetic data of the Chulitna mining area in Alaska acquired for the Division of Geological & Geophysical Surveys (DGGS) in 1996. The airborne geophysical data includes aeromagnetic and 900 Hz and 7200 Hz resistivity data. Included in this portfolio are color maps of the aeromagnetic and resistivity data, two shadow maps of the aeromagnetic maps, and an acetate overlay of the topography.

A brief description of the aeromagnetic and electromagnetic data is also presented in this Public-data File (PDF). Interpretation of the data and a more complete description of the processing is included in PDF 97-8.

The acetate topographic included with this portfolio should be used only for generalized locations. For accurate locations, the other geophysical maps or the computer files all released by DGGS should be used.

Any of the maps in this portfolio or customized maps are available at more useable scales from the Alaska Division of Geological & Geophysical Surveys, 794 University Ave., Suite 200, Fairbanks, Alaska, 99709. Phone: (907) 451-5020. FAX: (907) 451-5050. Custom plots of the data are available from the DGGS office.

The area surveyed includes parts of the Healy A-5, B-5, A-6, Mt. McKinley A-1, Talkeetna D-1, Talkeetna Mts. D-6, Quadrangles, Alaska.

Survey history, instrumentation, & data processing

The following indented section describing the instrumentation and processing is taken from the maps produced by WGM and DIGHEM, the contractor and subcontractor, in conjunction with the DGGS.

> The airborne geophysical data for the Chulitna mining area has been compiled and drawn under contract between the State of Alaska, Department of Natural Resources, Division of Geological & Geophysical Surveys, and WGM, Mining and Geological Consultants, Inc. Airborne geophysical data for the area was acquired by DIGHEM, a division of CGG Canada Ltd., in 1996.
>
> Geophysical data were acquired with a DIGHEM Electromagnetic (EM) system, a Scintrex cesium CS2 magnetometer, and a Herz VLF system installed in an AS350B-1 Squirrel helicopter. In addition, the survey recorded data from a radar altimeter, GPS navigation system, 50/60 Hz monitors, and a video camera. Flights were performed at a mean terrain clearance of 200 feet along 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 three miles.

A Sercel Real-Time Differential Global Positioning System(RT-DGPS) was used for both navigation and flight path recovery. The helicopter position was derived every 0.5 seconds using both real-time and post-processing differential positioning to a relative accuracy of less than 10 m. Flight path positions were projected onto the Clarke 1866 (UTM) spheroid, 1927 North American datum using a central meridian (CM) of 147 degrees, 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.

Total Field Magnetics:
The magnetic total field contours were produced using digitally recorded data from a Scintrex cesium CS2 magnetometer, with a sampling interval of 0.1 seconds. The magnetic 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, 1985 updated to October 1996) was removed from the leveled magnetic data.

Resistivity:
The DIGHEM^{V} EM system measured inphase and quadrature components at five frequencies. Two vertical coaxial coil-pairs operated at 900 and 5000 Hz while three horizontal coplanar coil-pairs operated at 900, 7200, and 56,000 Hz. EM data were sampled at 0.1 second intervals. For the 900 and 7200 Hz resistivity maps, the resistivity is generated from the inphase and quadrature component of the coplanar 900 and 7200 Hz respectively using the pseudo-layer half space model. The data were interpolated onto a regular 25 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.

Magnetic data

The magnetometer measures how magnetic the rocks are. Minerals that yield strong magnetic signals (measured in nanoteslas or nT) include most iron-rich minerals. The main magnetic minerals are magnetite, ilmenite, and pyrrhotite. 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 other geologic units. Rocks that commonly have little iron and tend to have little variation in the magnetic signal include silicic volcanic rocks (rhyolites), silicic plutonic rocks (granites), and most sedimentary rocks (for example, limestone, sandstone, and shale).

Figure 1 shows the aeromagnetic data for the Chulitna area. The high magnetic values (in nanoteslas) are shown in purple and orange and indicate appreciably magnetic rocks . The low values show up as blues and greens. A gradual change in the magnetic reading (shown here by color) indicates a gradual change in the magnetic strength of the rocks. Conversely, an abrupt change in color indicates an abrupt change in the magnetic strength. Faults can commonly be deduced from aeromagnetic maps as linear or curvilinear features composed of discontinuous aeromagnetic highs or lows. Commonly, an abrupt change of color in am aeromagnetic map occurs some place along a fault.

Figures 2 and 3 show the aeromagnetic data presented as "shadow" maps. These maps are produced as if a light source is shining on the data, displayed as a three-dimensional map. The higher data points appear bright like the top of mountain ranges when struck by sunlight. The light source can be rotated in a complete circle from O° (north) clockwise to 180° (south) and back to 360° (north.) Two different azimuths, 111° (apparent light source in the southeast) and 205° (apparent light source in the south-southwest) are shown in figures 2 and 3. Shadow maps can enhance structures, such as faults, intrusions, and the trend of stratigraphic layers.

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.

Resistivity data

The electromagnetic (EM) system measures how resistive the rocks below it are 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, conductive overburden (water-saturated zones), and cultural sources. Some of the main mineral conductors include graphite, most sulfides, (but not sphalerite), and water-saturated clays. Because they can contain clays, many hydrothermally altered rocks also are conductive. Some faults will show up very well on the resistivity maps, either because of water-saturated zones within the fault zone or because discontinuous linear zones of highs or lows, separate rocks with markedly different electromagnetic properties.

Several ways to use the EM data are possible. The EM anomalies shown on Report of Investigations RI 97-1 and PDF 97-26A-D with the aeromagnetic data are based on a near-vertical, half plane model. This model emphasizes "discrete" bedrock conductors. These anomalies are too numerous to place in this portfolio.

The EM data are also processed to produce resistivity maps, shown in figures 4 and 5. In this case, the maps are produced using a calculated model that emphasizes horizontal and flat-lying conductive units. The depth is variable depending on the type of rocks. The 900 Hz resistivity maps look deeper into the ground than the 7200 Hz. Although the color bars in these figures differ, each figure has the most conductive rocks shown as purple and orange.

More detailed discussions of the EM data are present in PDF 97-8 (specifically for the Chulitna area) and in PDF 95-12 (a generalized discussion that includes the Fairbanks area).

The topographic map is included as figure 6. This can be used as an overlay for the data.

Existing geologic maps:

Csejtey, Bela, Jr., Mullen, Michael W., Cox, Dennis P., and Stricker, Gary D., 1992, Geology and geochronology of the Healy Quadrangle, South-Central Alaska: U.S. Geological Survey Miscellaneous Investigations Series, Map I-1961, 63 p. (2 sheets, scale 1:250,000).

Csejtey, Bela, Jr., Nelson, W.H., Jones, D.L., Silberling, N.J., Dean, R.M., Morris, M.S., Lanphere, M.A., Smith, J.G., Silberman, M.L., 1978, Reconnaissance geologic map and geochronology, Talkeetna Mountains Quadrangle, northern part of Anchorage Quadrangle, and southwest corner of Healy Quadrangle, Alaska: U.S. Geological Survey Open-File Report 78-558-A, 60 p. (1 sheet, scale 1:250,000).

Hawley, C.C., and Clark, Allen L., 1973, Geology and mineral deposits of the Chulitna-Yentna Mineral Belt, Alaska, in Geology and mineral deposits of the upper Chulitna and Yentna districts, south-central Alaska: U.S. Geological Survey Professional Paper 758-A, p. A1-A10, 2 sheets; 1:250,000, 1:500,000 scale.

---, 1974, Geology and mineral deposits of the upper Chulitna District, Alaska, in Geology and mineral deposits of the upper Chulitna and Yentna districts, south-central Alaska: U.S. Geological Survey Professional Paper 758B, p. B1-B47, 2 sheets, 1:48,000, 1:12,000, 1:2,400 scale.

Jones, D.L., Silberling, N.J., Csejtey, Béla Jr, Nelson, W.H., and Blome, Charles D., 1980, Age and structural significance of ophiolite and adjoining rocks in the Upper Chulitna district, south-central Alaska, in Geologic Framework of the upper Chulitna district, Alaska: U.S. Geological Survey Professional Paper 1121-A, p. A1-A21, 2 plates in text, 1 sheet, 1:63,360 scale.

List of some corresponding publications by DGGS:

AEROMAGNETIC MAPS

RI 97-1. Total field magnetics and electromagnetic anomalies of the Chulitna mining district, Alaska. 1 sheet, 3 colors, scale **1:63,360.** Electromagnetic anomalies on this map show only the location and strength of the anomaly. See PDF 97-8A-F

RI 97-2. Total field magnetics of the Chulitna mining district, Alaska. 1 sheet, **full color**, scale 1:63,360. This takes the same aeromagnetic data shown in RI 97-1 and portrays it in color. The electromagnetic anomalies are not on this version.

PDF 97-26A. Total field magnetics and **detailed** electromagnetic anomalies of the northwest Chulitna mining district, Alaska. 1 sheet, **scale 1:31,680.** Electromagnetic anomalies are coded so that the probable source is given (i.e. cultural, thin bedrock conductor, etc.) as well as the strength of the anomaly.

PDF 97-26B. Total field magnetics and **detailed** electromagnetic anomalies of the northeast Chulitna mining district, Alaska. 1 sheet, **scale 1:31,680.** Electromagnetic anomalies are coded so that the probable source is given (i.e. cultural, thin bedrock conductor, etc.) as well as the strength of the anomaly.

PDF 97-26C. Total field magnetics and **detailed** electromagnetic anomalies of the southwest Chulitna mining district, Alaska. 1 sheet, **scale 1:31,680**. Electromagnetic anomalies are coded so that the probable source is given (i.e. cultural, thin bedrock conductor, etc.) as well as the strength of the anomaly.

PDF 97-26D. Total field magnetics and **detailed** electromagnetic anomalies of the southeast Chulitna mining district, Alaska. 1 sheet, **scale 1:31,680.** Electromagnetic anomalies are coded so that the probable source is given (i.e. cultural, thin bedrock conductor, etc.) as well as the strength of the anomaly.

RESISTIVITY MAPS

RI 97-3. 900 Hz resistivity contours of the Chulitna mining district, Alaska. 1 sheet, **full color**, scale 1:63,360.

RI 97-4. 7200 Hz resistivity contours of the Chulitna mining district, Alaska. 1 sheet, **full color**, scale 1:63,360.

PDF 97-3. 900 Hz resistivity contours of the Chulitna mining district, Alaska. 1 sheet, **blueline,** scale 1:63,360.

PDF 97-4. 7200 Hz resistivity contours of the Chulitna mining district, Alaska. 1 sheet, **blueline**, scale 1:63,360.

DIGITAL FILES. PROJECT REPORT, PORTFOLIO. AND FLIGHT LINES

PDF 97-1. Flight line maps of the Chulitna mining district, Alaska. 1 sheet, blueline, scale 1:63,360.

PDF 97-5. CD-ROM digital archive files of 1995 survey data for Chulitna and Petersville mining district, Alaska. Includes profile data, extraction program, and grids. Grids are compatible with Geosoft program and may be used for viewing the data on a computer imaging program and (or) plotting maps. The CD-ROM is useful for someone who wants to manipulate the processed line data.

PDF 97-6. One **disk containing gridded files** and section lines of 1996 geophysical survey data for Chulitna mining district, Alaska. Compatible with Geosoft program. Useful for someone who wants to view the data on a computer imaging program and(or) plot maps. Grids are slightly less refined than those on the CD-ROM.

PDF 97-7. Portfolio of aeromagnetic and resistivity maps of the Chulitna mining district, Alaska (this publication).

PDF 97-8. Project report of the airborne geophysical survey for the Chulitna mining district, Alaska.

Profile data for each channel on paper. Each sheet contains several flight lines.

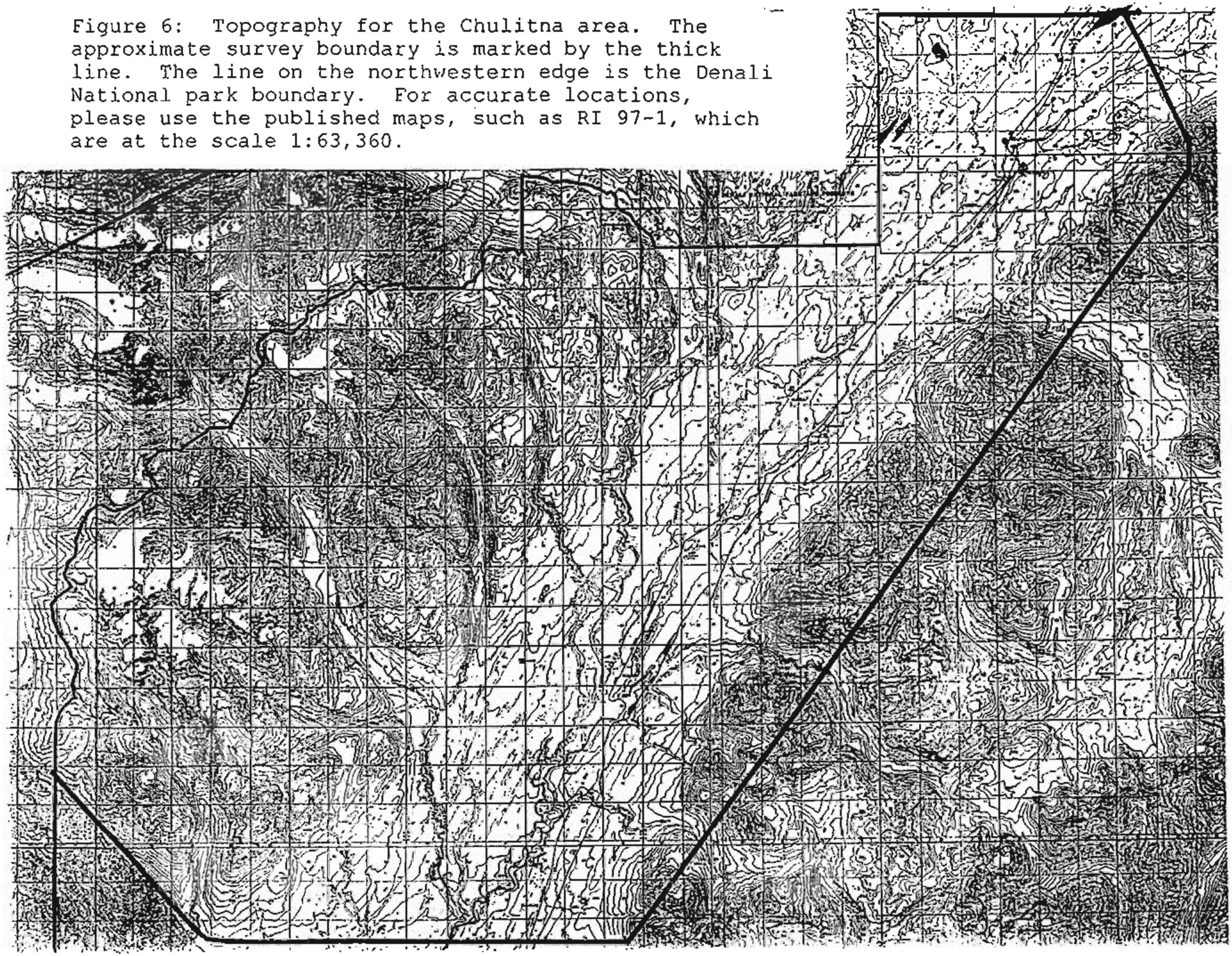

Figure 6: Topography for the Chulitna area. The approximate survey boundary is marked by the thick line. The line on the northwestern edge is the Denali National park boundary. For accurate locations, please use the published maps, such as RI 97-1, which are at the scale 1:63,360.

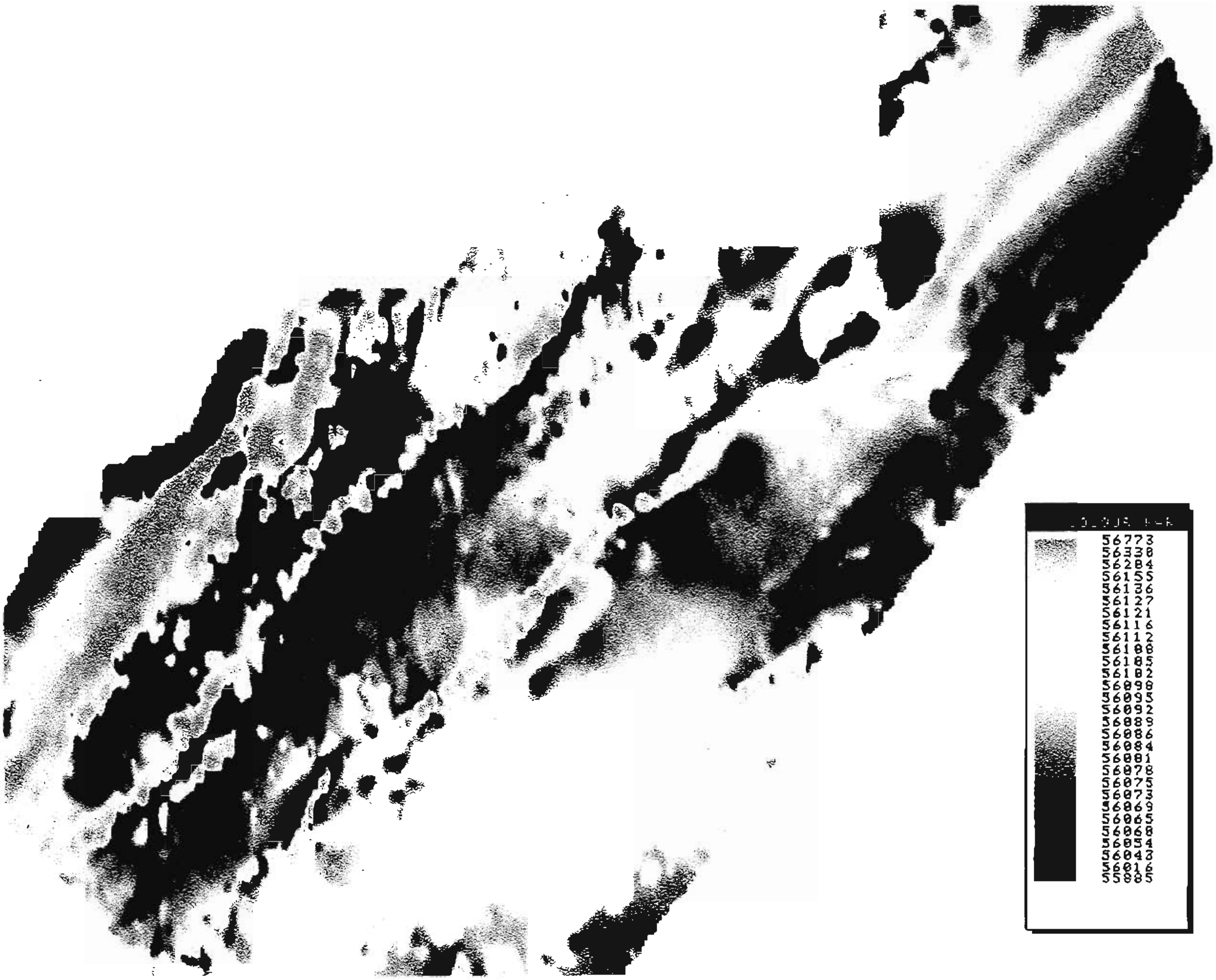

Figure 1: Aeromagnetic map of the Chulitna area, Alaska. Magnetic values in nanoteslas. Positive magnetic areas have high values and are shown in purple and orange.

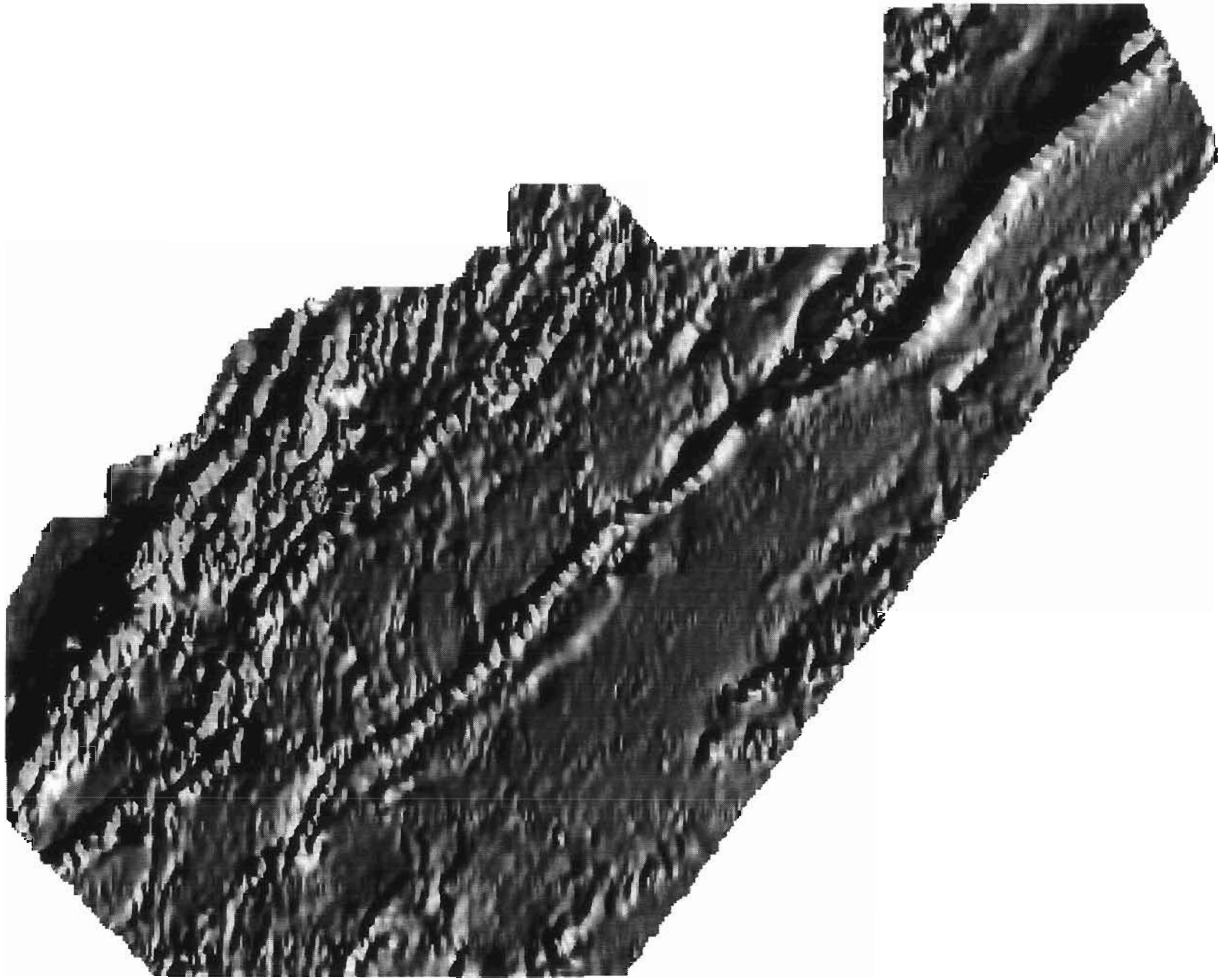

Figure 2: Shadow map of the aeromagnetic data from the Chulitna area, Alaska. Illumination source is at 111 degrees. High magnetic values appear like the tops of mountains that are hit by sunlight. This image emphasizes northeast and north trending structures.

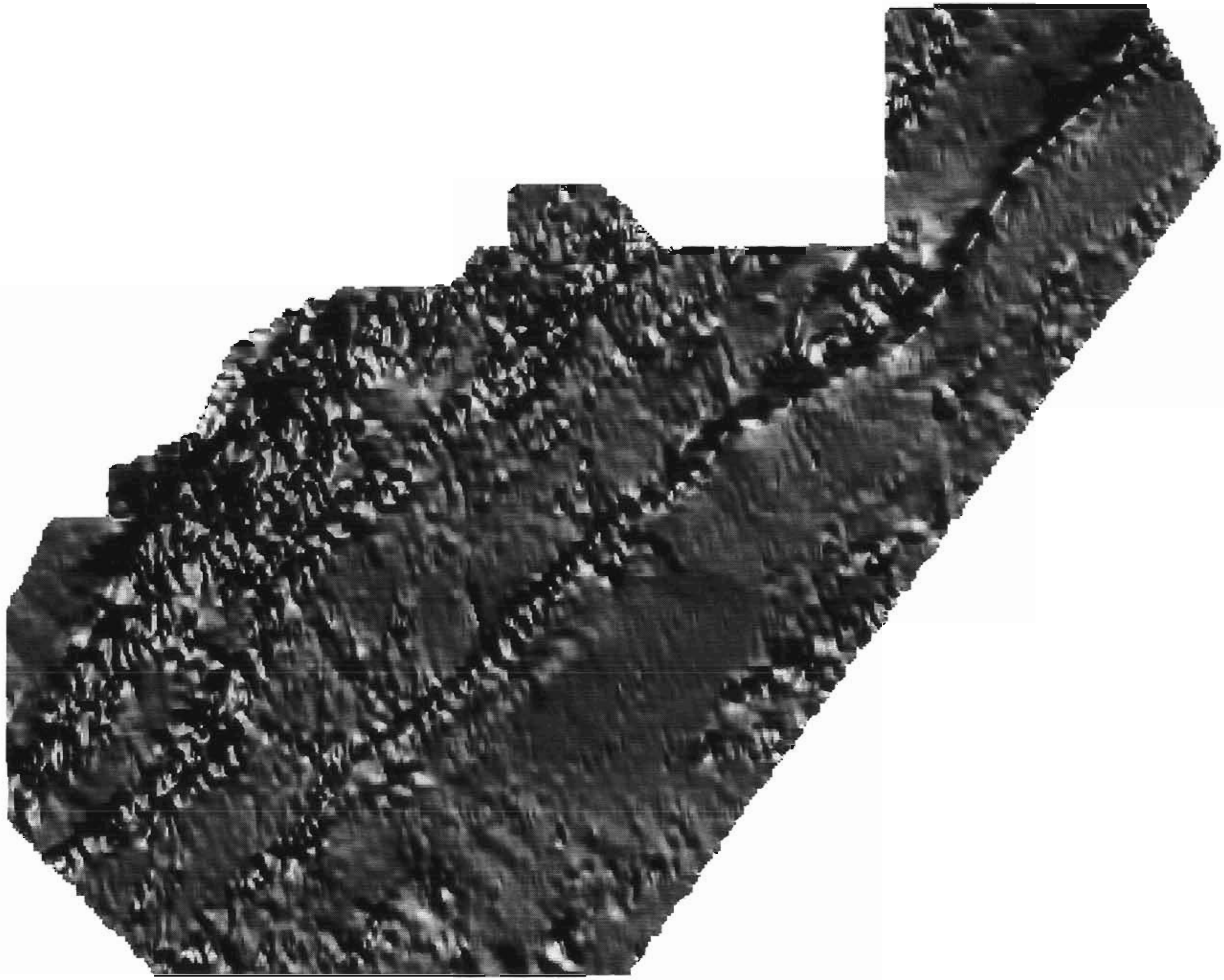

Figure 3: Shadow map of the aeromagnetic data from the Chulitna area, Alaska. Illumination source is at 205 degrees. High magnetic values appear like the tops of mountains that are hit by sunlight. This picture emphasizes northwest trending structures in the southern half of the image.

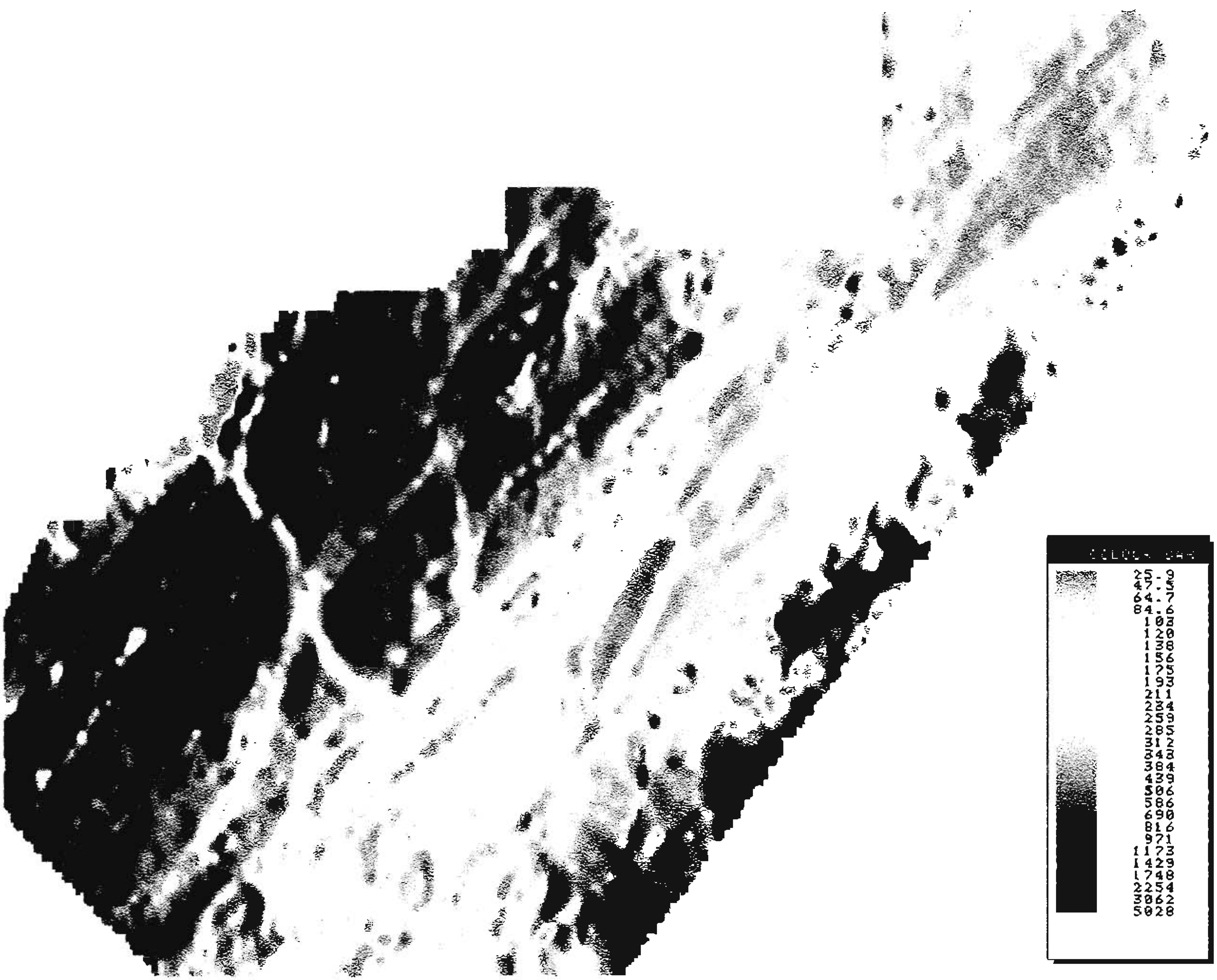

Figure 4: 7200 Hz resistivity map of the Chulitna area, Alaska. Resistivity values in ohm-m. Conductive units have low values and are shown in purple and orange on this map.

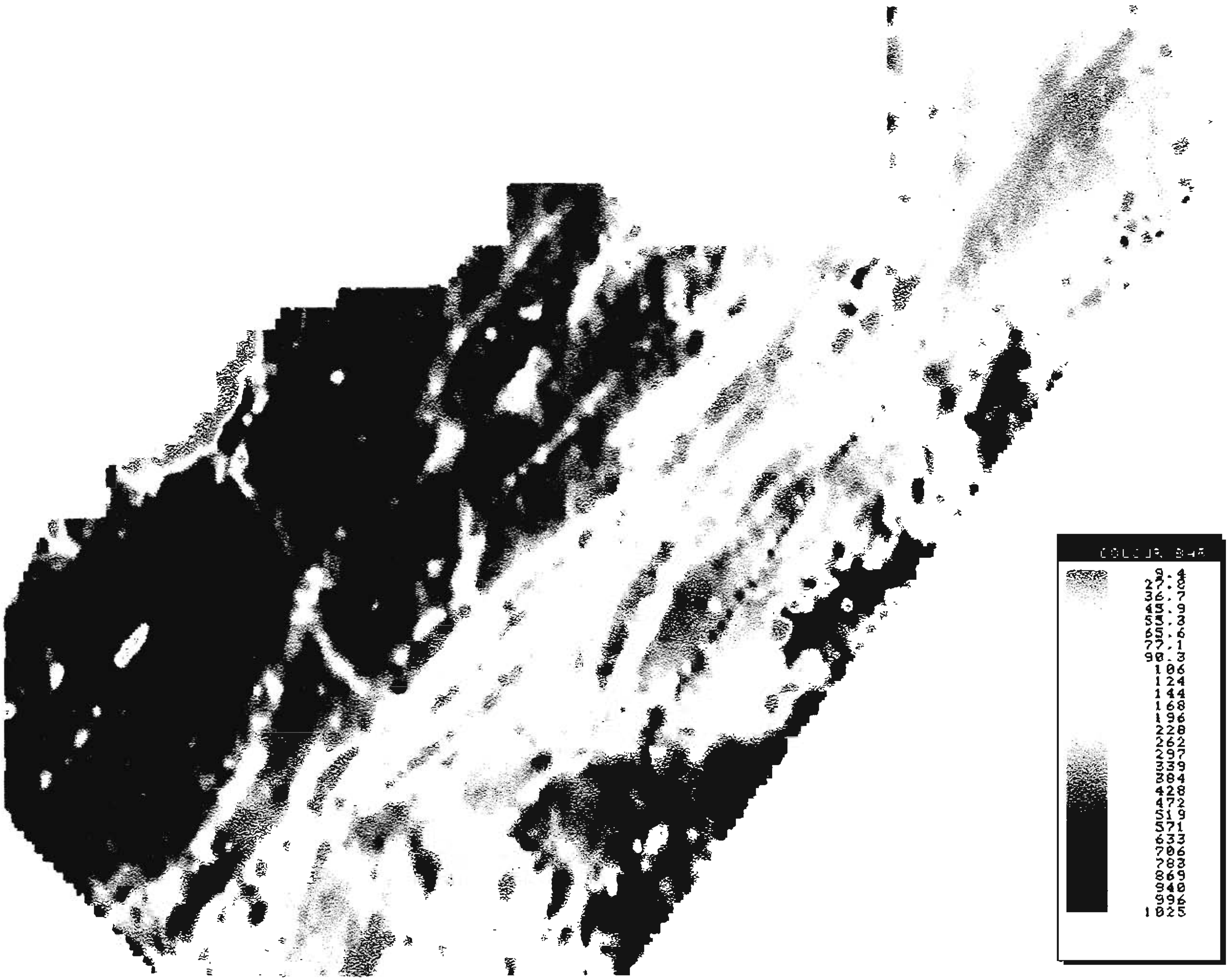

Figure 5: 900 Hz resistivity map of the Chulitna area, Alaska. Resistivity values in ohm-m. Conductive units have low values and are shown in purple and orange on this map.