



Digital Aeromagnetic Data and Derivative Products from a Helicopter Survey over the Town of Blanca and Surrounding Areas, Alamosa and Costilla Counties, Colorado.

By Viki Bankey, V.J.S. Grauch, and Fugro Airborne Surveys Corporation

Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government

Open-File Report 2004-1229B

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior

Gale A. Norton, Secretary

U.S. Geological Survey

Charles G. Groat, Director

U.S. Geological Survey, Reston, Virginia 2004
Revised and reprinted: 2004

For product and ordering information:
World Wide Web: <http://www.usgs.gov/pubprod>
Telephone: 1-888-ASK-USGS

For more information on the USGS—the Federal source for science about the Earth,
its natural and living resources, natural hazards, and the environment:
World Wide Web: <http://www.usgs.gov>
Telephone: 1-888-ASK-USGS

Although this report is in the public domain, permission must be secured from the individual
copyright owners to reproduce any copyrighted material contained within this report.

Digital Aeromagnetic Data and Derivative Products from a Helicopter Survey over the Town of Blanca and Surrounding Areas, Alamosa and Costilla Counties, Colorado

by Viki Bankey, V.J.S. Grauch, and Fugro Airborne Surveys Corporation

Abstract

This CD-ROM contains digital data, image files, and text files describing data formats and survey procedures for aeromagnetic data collected during a helicopter geophysical survey in southern Colorado during October 2003. The survey covers the town of Blanca and surrounding communities in Alamosa and Costilla Counties. Several derivative products from these data are also presented, including reduced-to-pole, horizontal gradient magnitude, and downward continued grids and images.

Introduction

This report describes data collected from a helicopter aeromagnetic survey flown over the town of Blanca and surrounding communities in Alamosa and Costilla Counties (Blanca survey on fig. 1). It is one of two surveys conducted in the San Luis Basin in October 2003 by Fugro Airborne Surveys Corporation under contract with the U. S. Geological Survey (USGS). The overall objective of these surveys is to improve knowledge of the subsurface geologic framework as part of multidisciplinary and multiagency efforts to understand ground-water systems in populated alluvial basins along the Rio Grande. Data for the Taos survey in southern Colorado are contained in a companion report (Bankey and others, 2004).

Organization of CD-ROM

The files on this CD-ROM and the contents of the four folders (directories) are briefly explained in table 1. The "readme.txt" file provides summaries of the contents of the CD-ROM. The four folders (directories) are organized as follows. Files pertaining to this report are contained in the "report" folder; files pertaining to the gridded data are contained in the "grids" folder; files pertaining to the flight-line data are contained in the "linedata" folder; and files pertaining to the color shaded-relief images are contained in the "images" folder. In the data folders, ASCII files with the extension ".txt" describe the format and contents of the data files. Please read the ".txt" files before using the data files.

Description of Data

Aeromagnetic data are collected using airborne geophysical sensors that measure subtle variations in the Earth's magnetic field. Aeromagnetic surveys are designed to map variations caused by the magnetic properties of underlying rocks. High-resolution surveys are flown closer to the ground and with narrower line spacing than conventional aeromagnetic surveys to better detect weakly magnetic rocks. A helicopter was used to collect data to maintain low clearance over the high-relief range fronts.

The aeromagnetic survey for the Blanca area (fig. 1) employed a helicopter flying along traverse lines oriented east-west, spaced 200 m (about 650 ft) apart, and flown a nominal 150 m (500 ft) above ground. Orthogonal lines were flown north-south at a 1000-m (3280-ft) spacing. Total line kilometers flown was 140.8 km. The east-west orientation of traverse lines was chosen because it is oblique to the predominant northerly to northeasterly geologic strike of the area. The flight-line data from the contractor are included in this report. Further details of the flight specifications, survey procedures, and data processing are included in Appendix A.

Derivative Products

Reduced-to-Pole Magnetic Data

The residual magnetic field channel had already been properly corrected using the Definitive Geomagnetic Reference Field by the contractors, so no further main field corrections were necessary before gridding. The data were interpolated onto a grid at 50-m intervals. Projection is UTM, zone 13 N (central meridian of 105° W. long., a false easting of 500,000 m, a false northing of 0 m, and using the NAD27 datum). The reduction-to-pole (RTP) transformation corrects for the offset between the locations of anomalies (closed highs or lows on a contour map) and their sources that is a consequence of the vector nature of the Earth's magnetic field (Blakely, 1995). To apply the reduced-to-pole transformation, one must assume that the total magnetizations of most rocks in the study area align parallel or antiparallel to the Earth's main field (declination=10°, inclination=64° for the study area). Based on considerations of rock type and age in the area, this assumption is generally valid (Grauch and others, 2004).

Enhanced Reduced-to-Pole Magnetic Data

The RTP magnetic grid was downward continued to a reference surface 100 m above ground, using the chessboard method of Cordell and Grauch (1985). In the chessboard method, the continued data are extrapolated from a series of parallel continuation surfaces that each have been computed using standard Fast Fourier transform (FFT) techniques (e.g., Blakely, 1995). The radar-altimeter channel was used to create the terrain clearance grid, which, in turn, determined the distances to continue the data. Radar-altimeter data from the contractor were leveled using the tie-line data to better approximate the flight surface. Downward continuation significantly enhances details in aeromagnetic maps but also amplifies noise. The downward continued, reduced-to-pole aeromagnetic data are presented as a color shaded-relief image. The zero level (datum) of these data is arbitrary.

Horizontal Gradient Magnitude

The edges of magnetic sources represent abrupt lateral rock-property contrasts that may occur at faults or steeply dipping contacts. The horizontal-gradient method is commonly used to detect magnetic source edges semiautomatically, using the horizontal gradient magnitude of pseudogravity data (Cordell and Grauch, 1985; Blakely and Simpson, 1986) or reduced-to-pole magnetic data (Phillips, 2000; Grauch and others, 2001). Pseudogravity data, or the magnetic potential, is a vertical integral of the reduced-to-pole magnetic data (Baranov, 1957; Blakely, 1995). The pseudogravity data (which have nothing to do with the observed gravity field) are derived from the original aeromagnetic data and enhance broad features at the expense of shorter-wavelength details. The slopes of pseudogravity or reduced-to-pole curves over magnetic sources are steepest over near-vertical edges. The steepest slopes are found from the maximum of the magnitude of the horizontal gradient, analogous to computing a derivative to find the inflection point of a curve.

Acknowledgments

We are thankful to the people of Blanca and surrounding communities for their tolerance during the low-level flying over their homes and businesses.

References cited

- Bankey, Viki, Grauch, V.J.S., and Fugro Airborne Surveys Corp., 2004, Digital aeromagnetic data and derivative products from a helicopter survey over the town of Taos and surrounding areas, Taos County, New Mexico: U.S. Geological Survey Open-File Report 2004-1229A, 10 p.
- Baranov, V., 1957, A new method for interpretation of aeromagnetic maps: pseudo-gravimetric anomalies: *Geophysics*, v. 22, p. 359-383.
- Blakely, R.J., 1995, *Potential theory in gravity and magnetic applications*: Cambridge University Press, 441 pp.
- Blakely, R.J., and Simpson, R.W., 1986, Approximating edges of source bodies from magnetic or gravity anomalies: *Geophysics*, v. 51, p. 1494-1498.
- Cordell, L., and Grauch, V.J.S., 1985, Mapping basement magnetization zones from aeromagnetic data in the San Juan Basin, New Mexico, *in* Hinze, W.J., ed., *The Utility of Regional Gravity and Magnetic Anomaly Maps*: Society of Exploration Geophysicists: Tulsa, Oklahoma, p. 181-197.
- Grauch, V.J.S., Bauer, P.W., and Kelson, K.I., 2004, Preliminary interpretation of high-resolution aeromagnetic data collected near Taos, New Mexico: *New Mexico Geological Society Guidebook* 55, in press.
- Grauch, V.J.S., Hudson, M.R., and Minor, S.A., 2001, Aeromagnetic expression of faults that offset basin fill, Albuquerque basin, New Mexico: *Geophysics*, v. 66, p. 707-720.
- Phillips, J.D., 2000, Locating magnetic contacts: a comparison of the horizontal gradient, analytic signal, and local wavenumber methods: 70th Meeting, Society of Exploration Geophysicists, Calgary, Expanded Abstracts.

Table 1. List of files, formats, and descriptions in this report.

FILE NAME	FORMAT TYPE	DESCRIPTION
readme.txt	ASCII text	Text file explaining how to read and use the files of this CD-ROM.
----- REPORT folder -----		
report.pdf	portable document format	A file containing the text of this report, with hyperlink to the appendix and figure.
appendix.pdf	portable document format	Contractor's report on the aeromagnetic data collection.
----- GRIDS folder -----		
gxinfo.txt	ASCII text	Description of grids with the extension .gxf and explanation of grid exchange format.
bmaggrd.gxf	grid exchange format	Leveled total-intensity magnetic data for the Blanca survey.
brtpgrd.gxf	grid exchange format	Reduced-to-the-pole (RTP) magnetic data for the Blanca survey.
brdrgrd.gxf	grid exchange format	Leveled radar altimeter measurements for the Blanca survey.
brcgrd.gxf	grid exchange format	Continued, reduced-to-the-pole (RTP) magnetic data for the Blanca survey. Data were continued to a surface 100 m above ground.
b83rcgrd.gxf	grid exchange format	Continued, reduced-to-the-pole (RTP) magnetic data for the Blanca survey. Data were continued to a surface 100 m above ground. Datum used is NAD83
bpdhggrd.gxf	grid exchange format	Magnitude of the horizontal gradient of pseudogravity for the Blanca survey. Pseudogravity was derived from continued RTP magnetic data.
brchggrd.gxf	grid exchange format	Magnitude of the horizontal gradient of continued RTP magnetic data for the Blanca survey.
e00info.txt	ASCII text	Description of grids with the extension .e00 and explanation of ARC exchange format.
bmaggrd.e00	ARC exchange format	Leveled total-intensity magnetic data for the Blanca survey.
brtpgrd.e00	ARC exchange format	Reduced-to-the-pole (RTP) magnetic data for the Blanca survey.
brdrgrd.e00	ARC exchange format	Leveled radar altimeter measurements for the Blanca survey.

FILE NAME	FORMAT TYPE	DESCRIPTION
brcgrd.e00	ARC exchange format	Continued, reduced-to-the-pole (RTP) magnetic data for the Blanca survey. Data were continued to a surface 100 m above ground.
b83rcgrd.e00	ARC exchange format	Continued, reduced-to-the-pole (RTP) magnetic data for the Blanca survey. Data were continued to a surface 100 m above ground. Datum used is NAD83.
bpdhggrd.e00	ARC exchange format	Magnitude of the horizontal gradient of pseudogravity for the Blanca survey. Pseudogravity was derived from continued RTP magnetic data.
brchggrd.e00	ARC exchange format	Magnitude of the horizontal gradient of continued RTP magnetic data for the Blanca survey.
-----LINEDATA folder -----		
linesinfo.asc	ASCII format	Description of the information and format of the flight-line data file.
blines.asc	ASCII format	Final information from the contractor for the Blanca survey as sampled along the flight lines.
-----IMAGES folder -----		
imginfo.txt	ASCII text	Description of the files containing color-shaded relief images developed in ERMapper from the magnetic data.
bmagimg.tif bmagimg.tfw	Tagged image format Geotif ASCII header file	Color shaded-relief image of leveled total-intensity magnetic data for the Blanca survey, and georegistration file. No text annotation or scales.
brcwimg.tif brcwimg.tfw	Tagged image format Geotif ASCII header file	Color shaded-relief image of continued, reduced-to-the-pole (RTP) magnetic data for the Blanca survey, and georegistration file. Image uses shading from the west. No text annotation or scales.
brcemg.tif brcemg.tfw	Tagged image format Geotif ASCII header file	Color shaded-relief image of continued, reduced-to-the-pole (RTP) magnetic data for the Blanca survey, and georegistration file. Image uses shading from the east. No text annotation or scales.
b83rcwimg.tif b83rcwimg.tfw	Tagged image format Geotif ASCII header file	Color shaded-relief image of continued, reduced-to-the-pole (RTP) magnetic data for the Blanca survey, and georegistration file. Datum used is NAD83. Image uses shading from the west. No text annotation or scales.

FILE NAME	FORMAT TYPE	DESCRIPTION
b83rceimg.tif b83rceimg.tfw	Tagged image format Geotif ASCII header file	Color shaded-relief image of continued, reduced-to-the-pole (RTP) magnetic data for the Blanca survey, and georegistration file. Datum used is NAD83. Image uses shading from the east. No text annotation or scales.
bpdhgimg.tif bpdhgimg.tfw	Tagged image format Geotif ASCII header file	Color shaded-relief image of magnitude of the horizontal gradient of pseudogravity for the Blanca survey, and georegistration file. No text annotation or scales.
brchgimg.tif brchgimg.tfw	Tagged image format Geotif ASCII header file	Color shaded-relief image of magnitude of the horizontal gradient of continued RTP magnetic data for the Blanca survey, and georegistration file. No text annotation or scales.
bmagprn.pdf	portable document format	Color shaded-relief image of leveled total-intensity magnetic data for the Blanca survey.
brdrprn.pdf	portable document format	Color image of leveled radar altimeter measurements for the Blanca survey. Flight-line locations are shown.
brwprn.pdf	portable document format	Color shaded-relief image of continued, reduced-to-the-pole (RTP) magnetic data for the Blanca survey. Image uses shading from the west.
brceprn.pdf	portable document format	Color shaded-relief image of continued, reduced-to-the-pole (RTP) magnetic data for the Blanca survey. Image uses shading from the east.
bpdhgprn.pdf	portable document format	Color shaded-relief image of magnitude of the horizontal gradient of pseudogravity for the Blanca survey.
brchgprn.pdf	portable document format	Color shaded-relief image of magnitude of the horizontal gradient of continued RTP magnetic data for the Blanca survey.

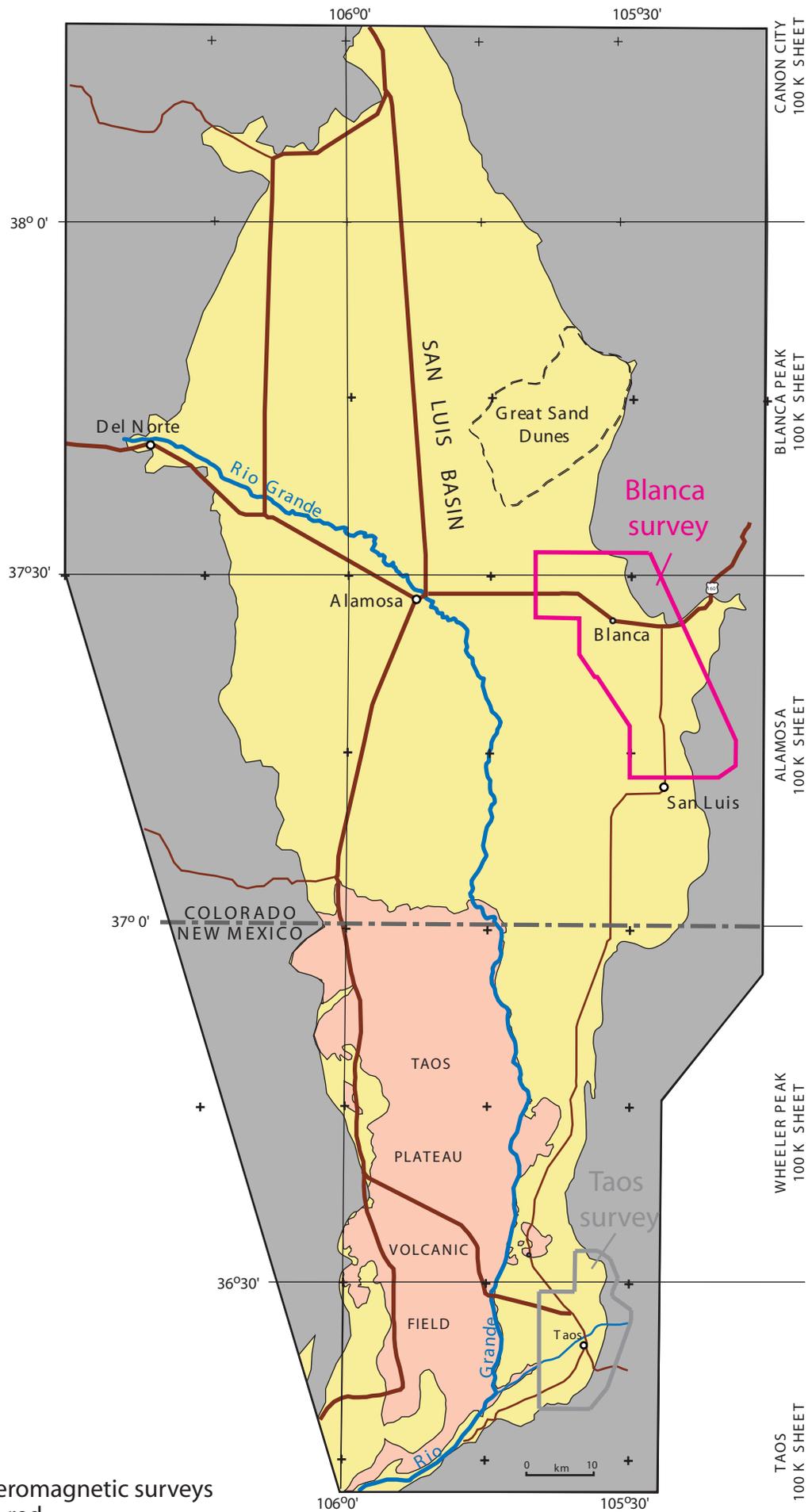


Figure 1. Location of aeromagnetic surveys are shown in red.