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Merged Aeromagnetic Data for the Southwestern United States

by

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INTRODUCTION

Aeromagnetic anomalies represent variations in the strength and direction of the Earth's magnetic field that are produced by rocks containing a significant number of magnetic minerals (commonly magnetite). The shape and magnitude of an anomaly produced by one body of rock are complexly related to the amount of magnetic minerals present, the magnetic properties of those minerals (determined by a number of factors, including the history of the rock), and the shape of the rock body. In this area, only crystalline basement rocks and volcanic rocks are likely to contain enough magnetic minerals to produce anomalies; sedimentary rocks and meta-sediments are generally so poor in magnetic minerals that their magnetic effects can not be detected by the types of surveys represented here. Patterns of anomalies on aeromagnetic maps can reveal not only lithologic differences related to magnetite content, but structural features as well, such as faults that have juxtaposed crystalline rocks against sedimentary rocks, and upwarps of crystalline basement underlying sedimentary sequences.

Tectonic features of regional extent may not become apparent until a number of aeromagnetic surveys have been compiled together. The resulting map gives a synoptic view of major tectonic features for a large region. Reducing all the data to a common observation specification then merging them into one uniform data set takes the compilation a step further. After merging, computer methods to enhance or model regional features crossing the survey boundaries can be applied. The reduction and merging process is labor-intensive and diminishes the accuracy of the data (Cordell, 1985), but it is required in order to proceed with desired computer analyses of the data.

The compilation and merging procedure begins by standardizing data from surveys that were flown at different times with widely disparate (and sometimes obscure) flight specifications and data reduction procedures. The standardized data are then analytically reduced to a common flight elevation and datum for each survey area, and digitally merged at the survey boundaries. Reducing all the data to an observation surface that parallels the topography and is lower than originally flown has some of the same advantages of low-altitude draped surveys. In draped surveys, magnetic anomalies caused by sources on mountaintops will tend to look similar to anomalies in valleys (if the sources are similar), which facilitates qualitative interpretation. Low-altitude data enhance small variations in the original data.

This report presents merged aeromagnetic data draped 1000 feet (304.8 m) above ground for Arizona, New Mexico, and parts of Nevada, Utah, and California (Fig. 1), which includes portions of the southern Colorado Plateau and southern Basin and Range Provinces. The Basin and Range area is also covered by the less-detailed aeromagnetic compilation of Hildenbrand and others (1983), which was reduced onto a much higher level (12,500 feet barometric elevation).

DATA COMPILATION

Total-intensity aeromagnetic data were obtained from three data sets compiled previously and from 8 original surveys (Fig. 1). Merged data sets with one common flight elevation were available for Nevada and part of southern California; survey data had been compiled for New Mexico, but had not been continued to a common elevation (Table 1). All original survey data were acquired in digital form where available, otherwise published contour maps were digitized by hand (Table 1). For each area, the data were projected using the Albers equal-area conic system (base latitude 0^{o}; central meridian 110^{o}W) then gridded using a minimum curvature algorithm (Webring, 1981) at a 2-km grid interval. (The previously compiled data sets required unprojection first.) Next, the modelled effects of the Earth's magnetic field, defined differently for the separate times each survey was flown, were removed from the original-survey-data grids. (Geomagnetic reference fields had already been removed from the previously compiled data.) The definitive and International Geomagnetic Reference Fields (DGRF and IGRF) were removed following the guidelines of the IAGA Division I Working Group 1 (1985) from six of the eight survey grids (Table 1). A crude geomagnetic field model, which was removed by the original contractors prior to contouring of one of these data sets (UT-1 on Fig. 1), was restored to the data before the DGRF model was removed. Geomagnetic models based on POGO were removed prior to data acquisition of the remaining two grids (UT-3 and UT-4 on Fig. 1).

To produce the merged data set, each grid was analytically continued to a draped surface 1000 feet above the ground by the interpolation method of Cordell (1985), save for the Nevada and California merged data sets, which required no continuation. Next, constant values were added to each grid to make the values of neighboring grids compatible, then the grids were merged together by splining across their edges (R. Sweeney, U. S. Geological Survey, unpub. computer program). Some difficulty in joining the grids is expected owing to differences in resolution, geomagnetic field removal, and data reduction of the original surveys. Gradients aligned exactly east-west or north-south may reflect survey boundary mismatches or may represent unresolvable problems with the original flight lines of a survey.

The merged aeromagnetic data are displayed on Figure 2 as a color shaded-relief map (produced by the unpub. computer program of M. W. Webring, U. S. Geological Survey). This map shows anomaly data as though it were topography, illuminated by a light source from the northwest. Data problems may be augmented on this kind of display, such as the merging problem along 33^{o} latitude in southeast New Mexico, and the north-south striping in the southwestern corner of Arizona which is flight-line noise. However, color shaded-relief maps easily reveal major magnetic anomaly patterns, enhance linear trends perpendicular to the illumination direction, and give better visual resolution to details.

ACKNOWLEDGMENTS

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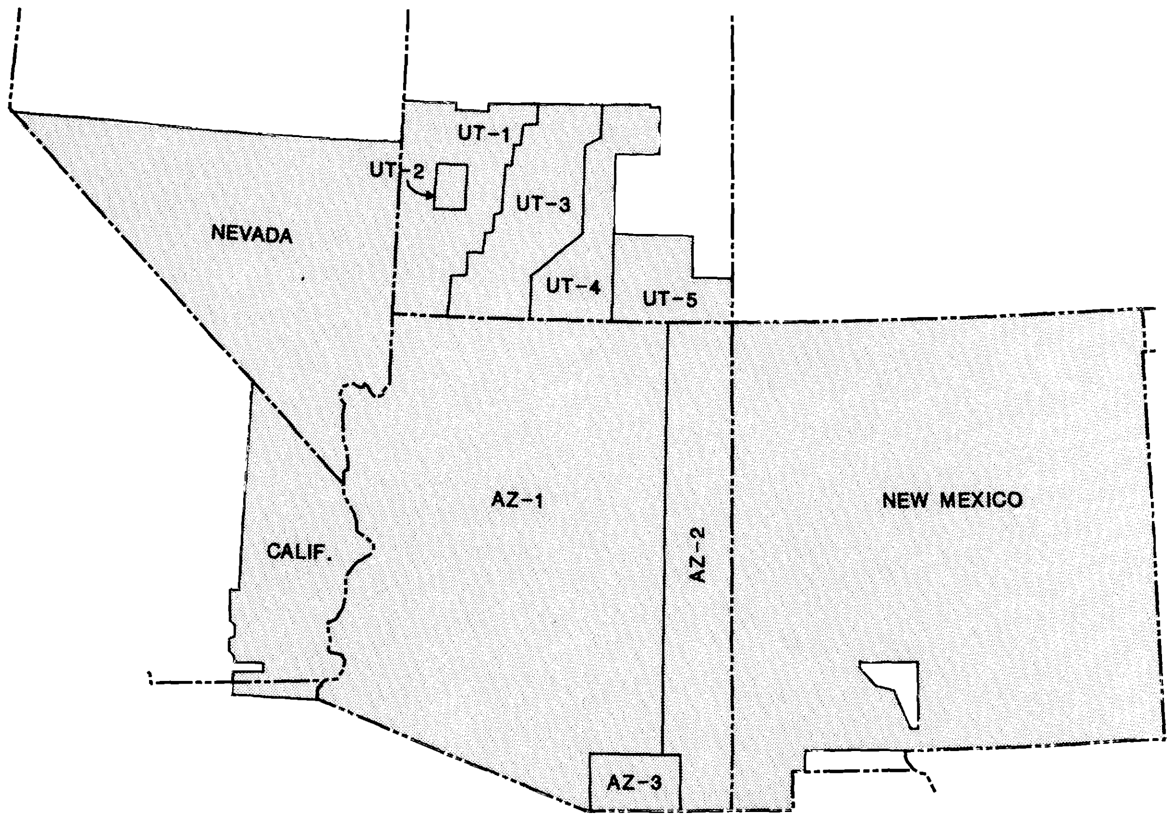


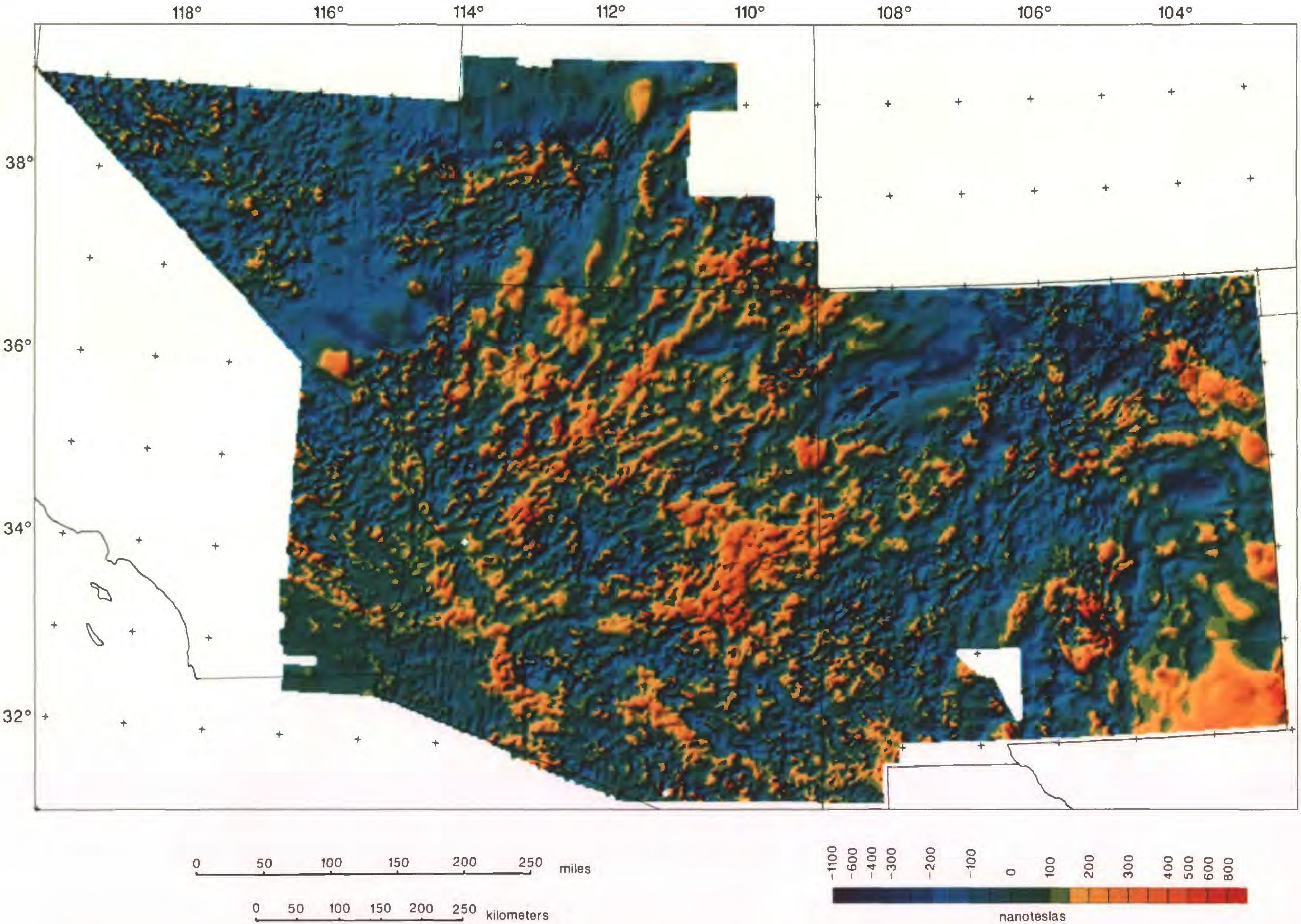
Figure 1. Aeromagnetic survey coverage for the data area. Data acquisition and flight specifications for each area are listed in Table 1. Two-letter codes with a number refer to subareas within one state.

TABLE 1. DATA AND SURVEY SPECIFICATIONS

AREA[1]	FLIGHT LINES	FLIGHT ELEVATION[2]	YEAR FLOWN	DATA TYPE	GEOMAGNETIC FIELD REMOVED[3]	REFERENCE
ARIZONA						
AZ-1	3-mi N-S	9,000′ BE	1968	Digital	GSFC (12/66)-1 [1]	Sauck and Sumner (1970)
AZ-2	3-mi N-S	11,000′ BE	1968	Digital	GSFC (12/66)-1 [1]	Sauck and Sumner (1970)
AZ-3	1-mi N-S	9,000′ BE	1964	Digitized	IGRF 1960-65 [2]	Andreasen and others (1965)
CALIFORNIA	merged data set	1,000′ AG	variable	variable	see reference	Mariano and Grauch, 1988
NEVADA	merged data set	1,000′ AG	variable	variable	see reference	Kucks and Hildenbrand, 1987
NEW MEXICO	composite data set	variable	variable	variable	see reference	Cordell, 1983
UTAH						
UT-1	1 & 2-mi N-S	9,000′ BE	1972	Digitized	DGRF 1970-75 [2]	U.S. Geological Survey (1972a,b)
UT-2	1-mi E-W	9,000′ BE	1963	Digitized	IGRF 1960-65 [2]	U.S. Geological Survey (1966)
UT-3	2 & 4-mi N-S	12,000′ BE	1971	Digital	POGO 6/71 [3]	Zietz and others, 1976
UT-4	2 & 4-mi N-S	8,500′ BE	1971	Digital	POGO 6/71 [3]	Zietz and others, 1976
UT-5	1-mi E-W	8,500′ BE	1954	Digitized	IGRF 1950-55 [2]	Case and Joesting, 1972

[1]Coded areas refer to Fig. 2.
[2]BE = barometric elevation, AG = above ground; in feet
[3]GSFC = Goddard Space Flight Center, month and year of model follow
IGRF = International Geomagnetic Reference Field; DGRF = definitive IGRF, linear interpolation was done between coefficients of the two model years shown; POGO = Polar Orbiting Global Observatory, month and year of model follow. Numbers in brackets refer to references as follows. 1 = Cain and others, 1967; 2 = IAGA Division I Working Group 1, 1985; and 3 = Langel, 1987, who discusses POGO models in general. The POGO model listed was provided to the survey processors by J. C. Cain (Florida State University) but never published.

Figure 2. Merged aeromagnetic map shown in color shaded relief, illuminated from the northwest.



118°
116°
114°
112°
110°
108°
106°
104°
38°
36°
34°
32°
0 50 100 150 200 250 miles
0 50 100 150 200 250 kilometers
-1100 -600 -400 -300 -200 -100 0 100 200 300 400 500 600 800
nanoteslas

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