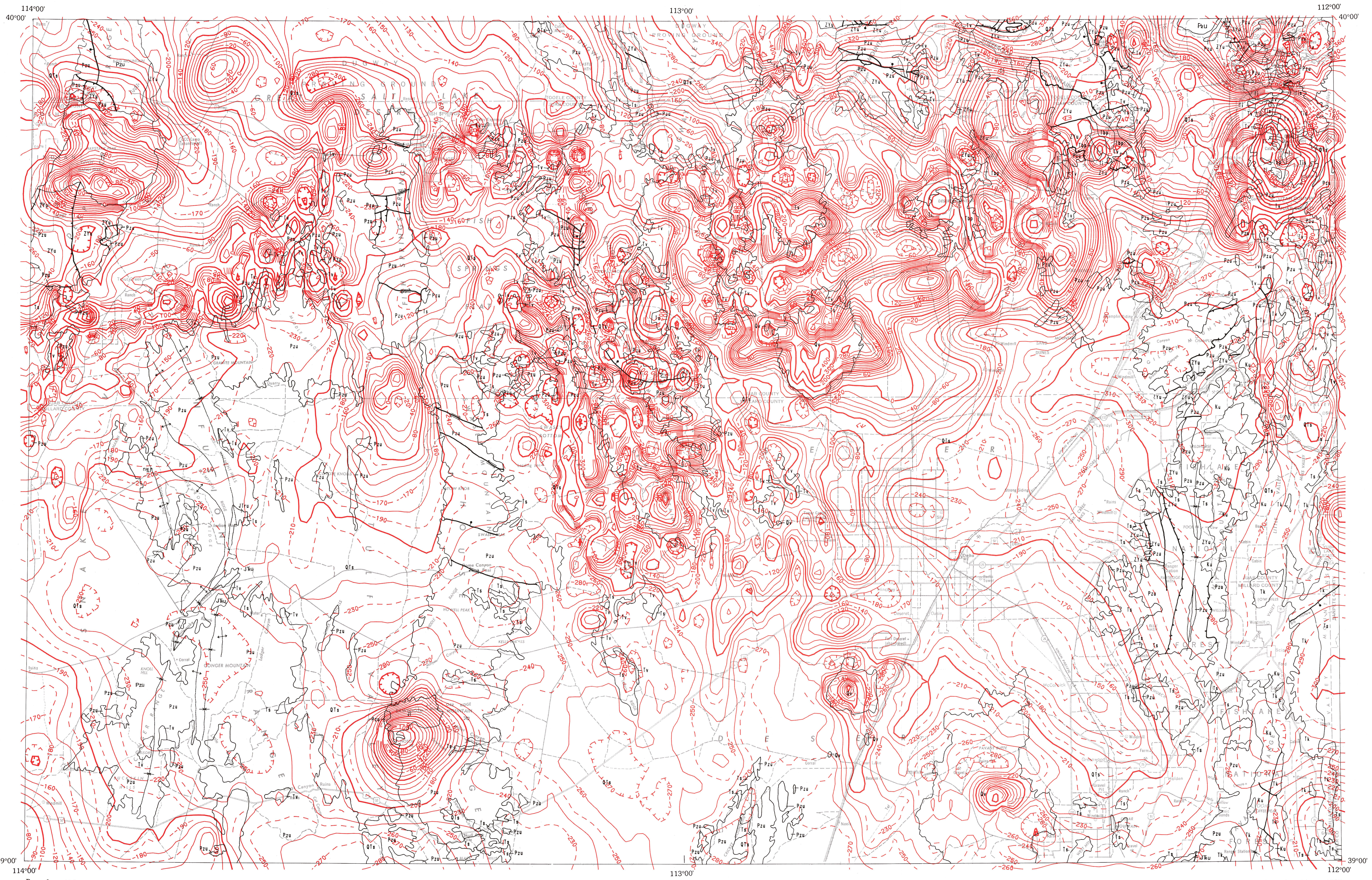


Base from U.S. Geological Survey, 1972

Geology from Morris, 1987

SCALE 1:250 000

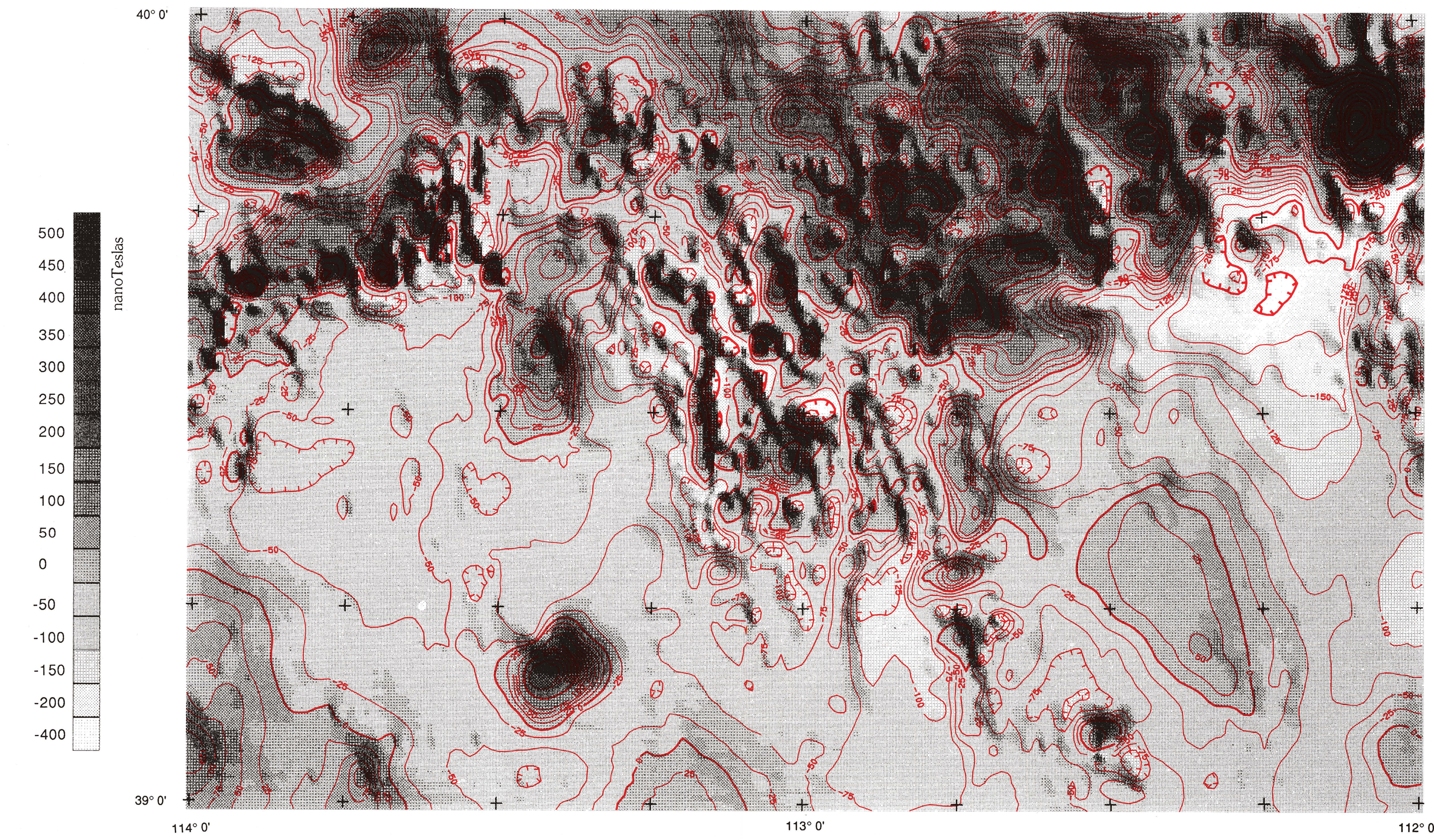
CONTOUR INTERVAL 200 FEET
WITH 100-FOOT SUPPLEMENTARY INTERVALS

QUADRANGLE LOCATION

EXPLANATION

Magnetic contours -- Contours show total residual magnetic intensity of Earth's field (in nanoTeslas, nT). Hachures indicate direction of decreasing intensity within closed magnetic lows. Contour intervals are 10, 20, and 100 nT

MAP A. AEROMAGNETIC-ANOMALY MAP

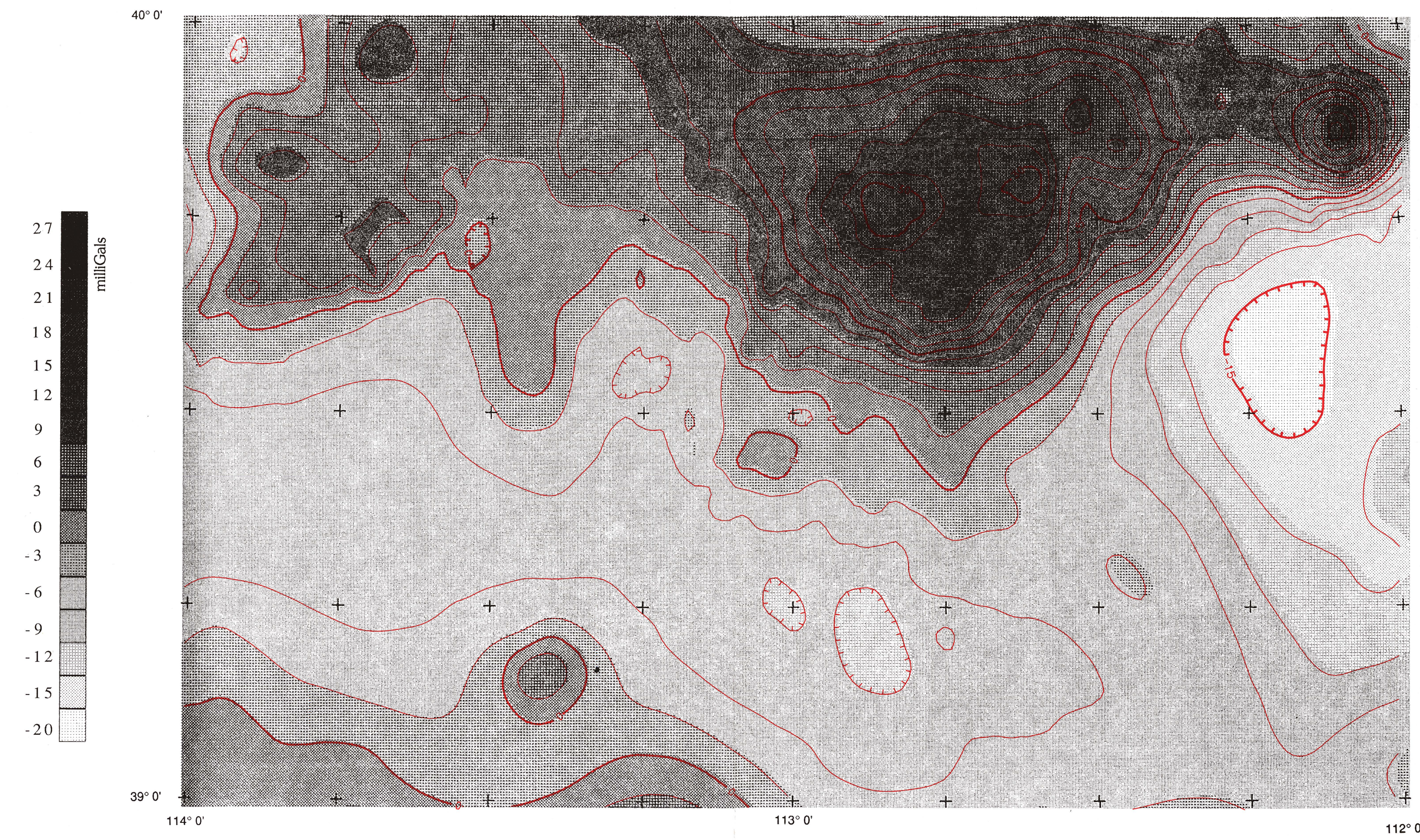


SCALE 1:500 000

EXPLANATION

Magnetic contours -- Contours show residual total-intensity magnetic-field values. Hachures indicate closure of magnetic low. Contour intervals are 20 and 200 nT

MAP B. MAP SHOWING RESIDUAL TOTAL MAGNETIC FIELD REDUCED TO THE NORTH MAGNETIC POLE (SOUTHWEST ILLUMINATION)

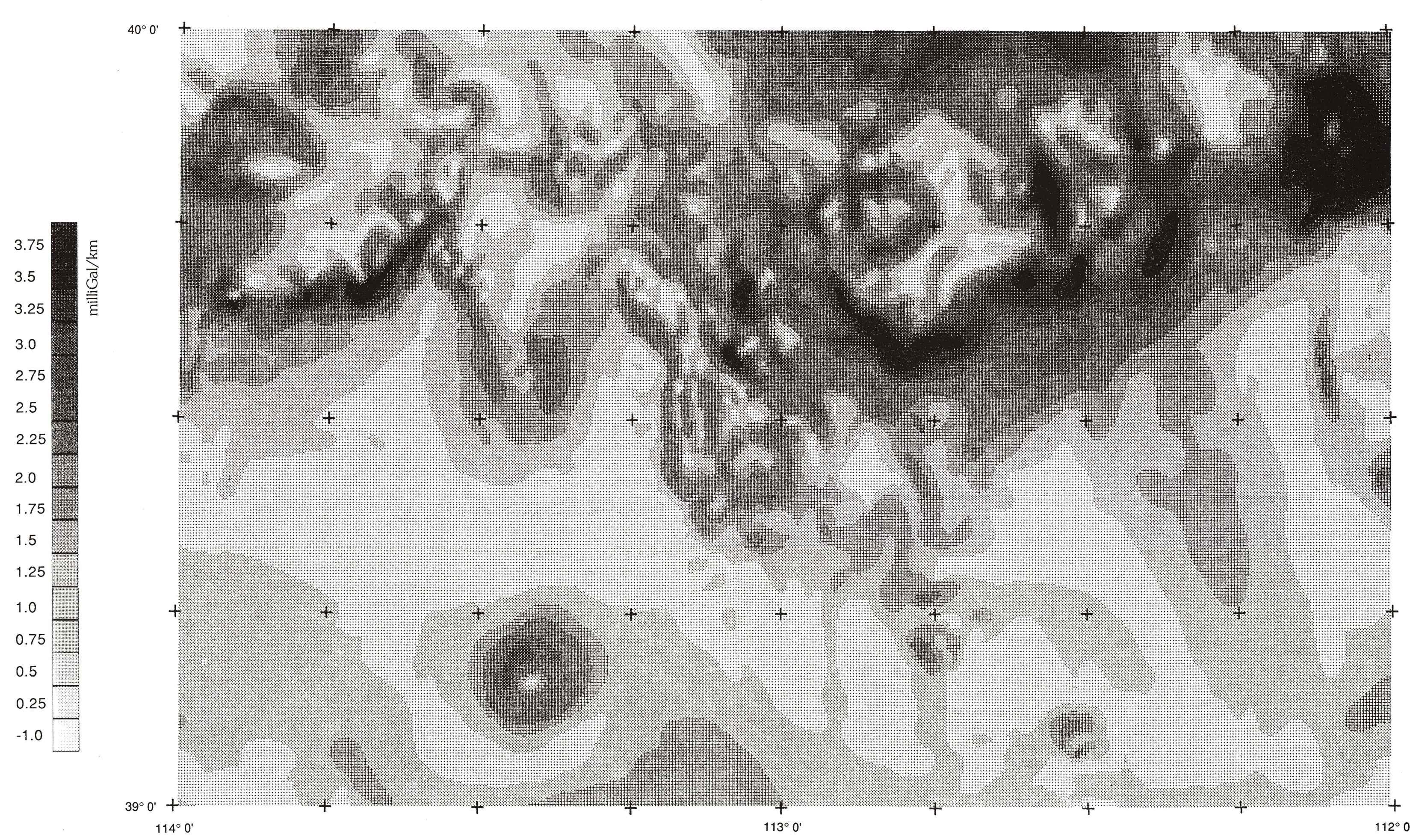


SCALE 1:500 000

EXPLANATION

Pseudogravity contours -- Contours show residual total-intensity magnetic-field values transformed to the gravity field. Hachures indicate closure of pseudogravity low. Contour intervals are 2 and 10 milligals

MAP C. MAP SHOWING PSEUDOGRAVITY FIELD



SCALE 1:500 000

MAP D. MAP SHOWING MAGNITUDE OF HORIZONTAL GRADIENT OF PSEUDOGRAVITY FIELD

DESCRIPTION OF MAP UNITS

Qv **Quaternary volcanic deposits (Pleistocene and Holocene)**--Flows and pyroclastic deposits of basalt and basaltic andesite

QTs **Alluvium and valley fill deposits (Holocene, Pleistocene, and Pliocene)**--Colluvium and alluvium in upland areas and fanglomerate, lacustrine units, eolian deposits, and tuffaceous beds in valleys and basins

Tbp **Breccia pipes (Oligocene)**--Plug- and dike-like bodies containing large and small blocks of Tertiary, Paleozoic, and Precambrian rocks embedded in a matrix of rock fragments, rock flour, and volcanic microbreccia

Tis **Sills (Oligocene)**--Extensive sheets of porphyritic latite injected into eruptive rocks of the Tintic Mountain Volcanic Group

Ti **Intrusive bodies (Tertiary)**--Stocks, plugs, and dikes ranging in composition from basic monzonite and latite to alkali granite and rhyolite; chiefly associated with volcanic rocks in the eruptive centers

Tv **Tertiary volcanic deposits (Pliocene through Eocene)**--Flows, ignimbrites, pyroclastic deposits, and agglomerates ranging in composition from basalt to alkali rhyolite generally localized in well-defined eruptive centers in northern part of quadrangle

Ts **Tertiary sedimentary deposits (Pliocene through Paleocene)**--Conglomerate, sandstone, shale, limestone, and other continental deposits including Flagstaff, Colton, Green River, Crazy Hollow, Bald Knoll, and other pre-volcanic formations, and Oak City, Fool Creek, and other post-volcanic units

Tk **North Horn Formation (Tertiary and Cretaceous)**--Red and green post-orogenic shale, sandstone, conglomerate, and limestone. Contains mammalian remains in upper part and dinosaurian remains in the lower part

Ku **Cretaceous strata, undivided**--Red orogenic conglomerate, sandstone, and minor shale commonly characterized by large, semi-rounded clasts of quartzite and carbonate rocks. Chiefly consists of Canyon Range, Price River, and Indianola Conglomerates; locally includes some Paleocene strata

Ji **Jurassic pluton**--Pinkish-gray to white, coarsely crystalline quartz monzonite porphyry stock cutting Cambrian strata in House Range. Age is estimated to be 143 Ma

JŦu **Jurassic and Triassic strata, undivided**--Includes Thaynes Limestone in western part of quadrangle and Moenkopi, Chinle, and Navajo Formations in eastern part of quadrangle

Pzu **Paleozoic strata, undivided (Permian through Cambrian)**--Includes strata deposited during each period of the Paleozoic Era. These strata are composed of about 60 percent carbonate rock, 30 percent quartzite and sandstone, and 10 percent shale, and are subdivided into as many as 20 or 30 formational units in any one area

ZYu **Precambrian Z and Y strata, undivided (upper and middle Proterozoic)**--Chiefly quartzite, argillite, and glaciogenic diamictite, with some local beds of algal limestone all subdivided into 6 or more formational units or sequences

Contact--Dashed where approximately located

High-angle fault--Bar and ball on downthrown side; arrows show direction of relative horizontal displacement

Thrust fault--Sawteeth on upper plate. Dotted where concealed; groups of three dots where inferred and concealed. Most concealed positions approximately located

Anticline--Showing trace of axial plane; dotted where concealed

Syncline--Showing trace of axial plane; dotted where concealed

INTRODUCTION

A set of digital aeromagnetic data for the Delta 1° x 2° quadrangle Conterminous U.S. Mineral Assessment Program (CUSMAP) project was compiled from National Uranium Resource Evaluation (NURE) radiometric and magnetic reconnaissance surveys. The final grid of values consists of 1.0 km x,y cells on a Universal Transverse Mercator (UTM) projection (central meridian longitude 113° W.). The original flight altitude of 0.122 km (400 ft) for each survey was maintained for the final data set. The availability of this internally compatible data set allows application of a variety of analytical techniques (reduction to the north magnetic pole, pseudogravity transformation, and horizontal gradient of pseudogravity) that can enhance anomalies and provide new interpretive information.

DATA REDUCTION

The magnetic-anomaly map was compiled from data obtained during three NURE magnetic surveys. The surveys were flown with a flight-line spacing of 1.6-4.8 km (1-3 mi) at a flight altitude of 0.122 km (400 feet) above mean terrain, and data spacing along flight lines of 43-120 m (140-394 ft) ground distance. The residual total-intensity magnetic values supplied by the contractor were used to produce the digital data set. A constant geomagnetic reference field had been removed from each survey to produce these residual values. Compilation of the three surveys produced overlaps of coverage in many cases. The best representation of data based on survey specifications and visual inspection was chosen to produce the final survey limits (as indicated on the index map). The individual sets were then merged to produce one consistent data base for the complete quadrangle. After the data were projected to the aforementioned specifications, it was gridded using a computer program (Webring, 1982) based on minimum curvature (Briggs, 1974) at a representative 1-km interval. The data were gridded as one set, rather than as individual surveys and then merged, in order to minimize merge-boundary artifacts. The flight-line spacing for survey 'B' is inconsistent, negating any advantage of a finer grid interval to increase data resolution. The final grid (map A) was then contoured using a computer program developed by Godson and Webring (1982). A program developed by Hildenbrand (1983) that uses parameters specified in the following sections created the grids that produced maps B, C, and D. Proprietary software and an unpublished computer program developed by M. Webring (U.S. Geological Survey) generated the gray-shade images of maps B, C, and D, while the contours were produced as noted above.

REDUCTION TO THE NORTH MAGNETIC POLE (MAP B)

Rocks may contain magnetic minerals (such as magnetite) that possess a type of magnetization proportional to and oriented in the direction of the Earth's present-day magnetic field; such magnetization is referred to as "induced." In addition to induced magnetization, rocks may also possess an additional permanent (or remanent) magnetization (with highly variable orientations) acquired during the rock's history. The polarization vector of a magnetic body is the sum of the remanent- and induced-magnetization vectors.

The shape of a magnetic anomaly depends on many factors, including the direction of magnetization of the causative body and the direction of the Earth's ambient magnetic field (Nettleton, 1971). For example, at moderate to high latitude in the northern hemisphere, an intrusion that possesses induced magnetization is a magnetic high whose peak is located several kilometers south of the intrusion's center and has a less intense magnetic low flanking it on the north. To remove these types of polarization effects from a map, the data are analytically reduced to the North Magnetic Pole (Bhattacharyya, 1965). The advantages of the reduction are that the anomalies become symmetrical around the source and thus are centered above it. The direction of polarization of the magnetic anomaly and that of the Earth's magnetic field are needed to make the reduction to the North Pole. To make the calculation, we assumed that direction of magnetization of all the rock units is nearly coincident with the Earth's present-day inducing field (inclination 65.3° N. and declination 14.9° W.). This is equivalent to supposing that induced magnetization is dominant over remanent magnetization in the rocks of the Delta quadrangle. The errors that result from assuming only induced magnetization in the quadrangle are not likely to be important when studying anomalies at 1:500,000 scale.

PSEUDOGRAVITY TRANSFORMATION (MAP C)

Gravity and magnetic anomalies caused by a common source of magnetization and density contrasts are related to each other by Poisson's relation. Baranov (1957) suggested using Poisson's relation to calculate what he termed a pseudogravity-anomaly map constructed from magnetic data. In the present study, the transformation of the magnetic field to the pseudogravity field requires no assumption regarding a common source of magnetization and density. The magnetization contrast related to a magnetic source is converted to a proportional density contrast to take advantage of analyses in terms of gravity, as will be evident with the pseudogravity gradient. However, the pseudogravity field is comparable to the actual gravity field of the Delta quadrangle (Bankey and Cook, 1989) to delineate common sources of magnetization and density. In the calculations, the ratio of the rocks' magnetization contrasts to density contrasts was set to a constant value (1,000 nanoTeslas /g/cm³) and induced magnetization in a uniform direction (inclination 65.3° N. and declination 14.9° W.) was assumed.

PSEUDOGRAVITY GRADIENT (MAP D)

Cordell (1979) made use of horizontal gravity-gradient maxima to map graben-bounding faults. The principle of this technique, designed to delineate lithologic or structural boundaries, was later extended to the analysis of magnetic data through use of the pseudogravity transformation (Cordell and Grauch, 1985). Having made the pseudogravity transformation on the residual total-intensity magnetic grid (map C) the magnitude of the horizontal pseudogravity gradient (g) was determined by using an unpublished computer program (R.W. Simpson, U.S. Geological Survey) using the following coordinates: where x is the longitudinal coordinate, y is the latitudinal coordinate, and (j) is the pseudogravity field defined at grid point i,j. Pseudogravity gradient maxima are located directly over steep or vertical boundaries separating rock units that possess contrasting magnetization values. On the pseudogravity gradient map, lines drawn (Blakely and Simpson, 1986) along ridges formed by enclosed high horizontal-gradient magnitudes correspond to these boundaries (see red lines on map). The maximum gradient will shift somewhat from the actual position of the boundary if the boundaries dip and if remanent magnetization is strong or if contributions from adjacent magnetic sources are significant, (Grauch and Cordell, 1987).

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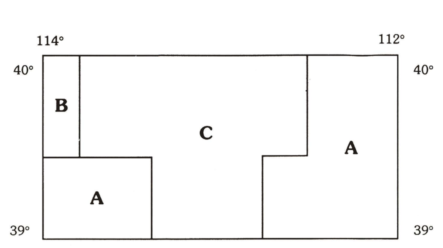

Figure 1 Index map showing locations of individual surveys used for this report; letters refer to table below

Aeromagnetic Survey Flight Specifications

Survey	Direction	Spacing (miles)	Altitude (feet)	Precision (ground feet)
A	E-W	3.0	400 AMT	140
B	E-W	1.0	400 AMT	140
C	E-W	2.0	400 AMT	394

AEROMAGNETIC-ANOMALY MAP AND RELATED GEOPHYSICAL MAPS OF THE DELTA 1° x 2° QUADRANGLE, UTAH

By

Robert P. Kucks

1991

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