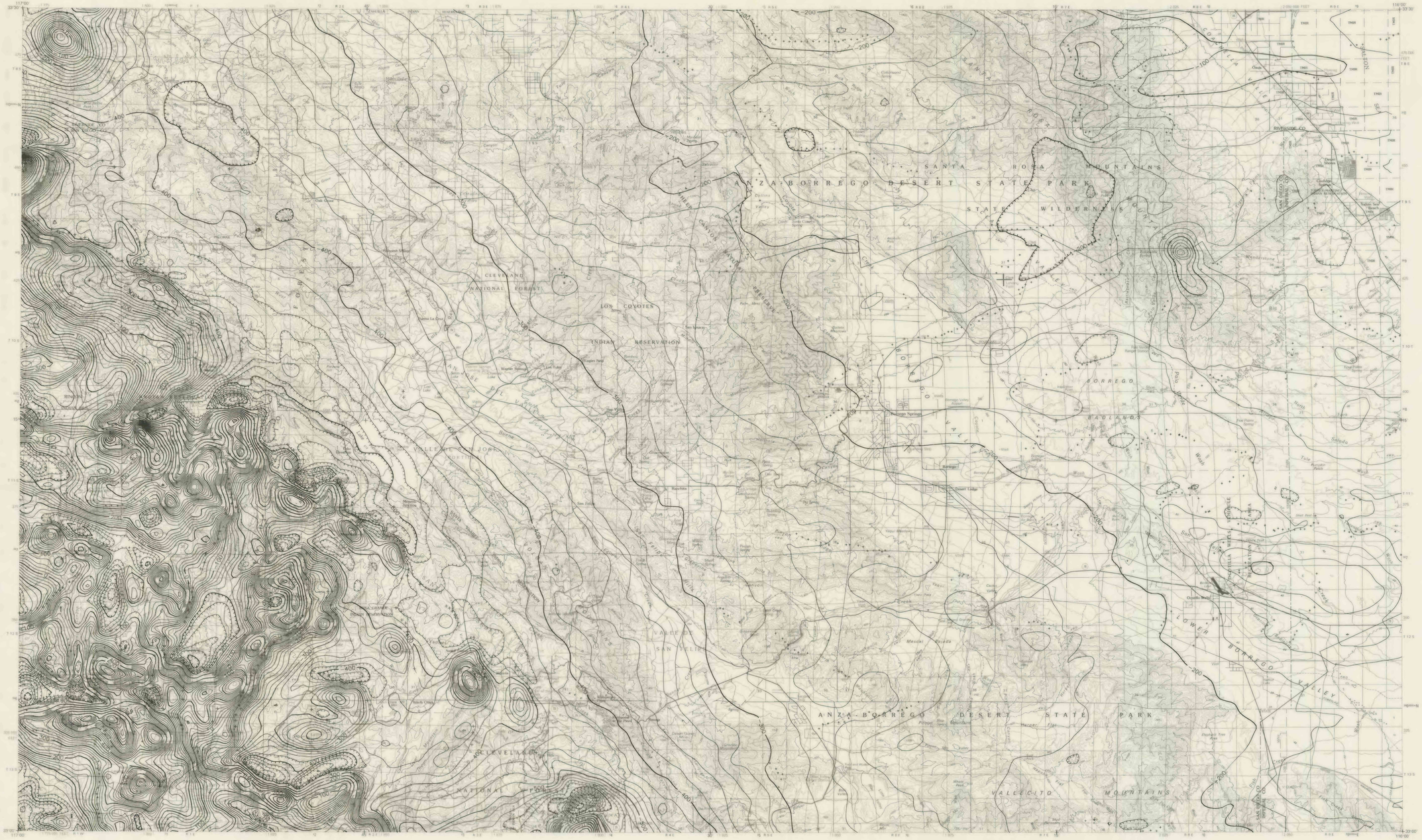
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN FILE REPORT
93-283



Base from U.S. Geological Survey, 1982
Universal Transverse Mercator projection

Index Map of Aeromagnetic Surveys

APPROXIMATE MEAN DECLINATION, 1993

SCALE 1:100 000

KILOMETERS 0 1 2 3 4 5 6 7 8 9 10

MILES 0 1 2 3 4 5

FEET 0 5000 10000 15000 20000 25000

CONTOUR INTERVAL 40 METERS
SUPPLEMENTARY CONTOUR INTERVAL 20 METERS

AEROMAGNETIC MAP OF THE BORREGO VALLEY 1:100,000 SCALE QUADRANGLE, CALIFORNIA

By

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1993

QUADRANGLE LOCATION

Contours of total magnetic field intensity relative to the International Geomagnetic Reference Field. Contour interval is 20 nanoteslas. Hachures indicate closed magnetic lows. Small "plus" signs indicate possible locations of boundaries between regions of different magnetizations (see accompanying text for explanation).

INTRODUCTION

The accompanying aeromagnetic map is part of the Southern California Areal Mapping Project (SCAMP) and is intended to promote further understanding of the geology in the Borrego Valley 1:100,000-scale quadrangle, California by serving as a basis for geophysical interpretations and by supporting geological mapping, mineral resource investigations, and topical studies. Local spatial variations in the Earth's magnetic field (evident as anomalies on aeromagnetic maps) reflect the distribution of magnetic minerals, primarily magnetite, in the underlying rocks. In many cases the volume content of magnetic minerals can be related to rock type, and abrupt spatial changes in the amount of magnetic minerals commonly mark lithologic boundaries. Bodies of gabbroic or dioritic composition tend to produce the most intense magnetic anomalies, but such generalizations must be applied with caution because rocks with more felsic compositions also are capable of causing measurable magnetic anomalies.

Within the Borrego Valley quadrangle, magnetic minerals are concentrated mainly in the Mesozoic plutonic rocks of the Peninsular Ranges batholith (Rogers, 1965). The profound difference in map pattern between the southwestern part and the rest of the map area reflects a fundamental east-west asymmetry in the composition of the batholith. Magnetite-rich, mafic plutons are confined to the western part whereas the plutonic rocks in the eastern part are effectively nonmagnetic (Jachens and others, 1986; Castil and others, 1990; Todd and others, 1991). The magnetic anomaly pattern of numerous local highs and lows in the southwestern part indicates that the igneous rocks are not uniformly magnetic, but rather have a wide range of magnetizations.

At the scale of this map, most magnetic anomalies bear a direct relationship to the rocks beneath them, i.e., magnetic highs are associated with magnetic rock bodies. In detail, however, because the Earth's main magnetic field is not vertical at the latitude of the Borrego Valley quadrangle (field inclination -60°) and because almost all of the anomalies on this map are induced by the earth's main field, the precise relationship between a magnetic body and its associated anomaly is complex. Typically, each magnetic body will generate a magnetic anomaly composed of a high and a low, with the high lying over the southern part of the body and the axis of the low lying just north of the northern edge of the body.

One magnetic feature on this map is somewhat different from those described in the previous paragraph and therefore warrants additional explanation. The smooth, widely spaced, generally northwest-trending contours that occupy much of the central part of the map and indicate increasing field strength toward the northeast do not reflect a progressive northeastward increase in magnetization of the underlying rocks. Rather, the increase in field strength simply represents the northeast side of the deep magnetic low that lies on the northeast side of the collection of highly magnetic plutons that occupy the southwestern part of the map area. The low extends a substantial distance northeast of the magnetic rocks because the rocks extend to mid-crustal depths and their northeastern boundary dips northeastward (Jachens and others, 1986).

DATA SOURCES AND REDUCTIONS

Total-field magnetic data from two separate surveys (table 1, index map) were used to construct the aeromagnetic map of the Borrego Valley quadrangle. Data from the two surveys are from original digital tapes provided by the contractors. The International Geomagnetic Reference Field, updated to the dates that the individual surveys were flown, was subtracted from each survey to yield a residual magnetic field.

TABLE 1

Survey	Year Flown	Flight Elevation (Above ground surface)	Flight Line Spacing	Direction
Salton Sea (U.S. Geological Survey, 1983)	1981	305 m	0.8 km	E/W
San Diego (U.S. Geological Survey, 1990)	1989	305 m	0.8 km	NE/SW

Data from the surveys were projected (Universal Transverse Mercator Projection; Base Latitude 0°, Central Meridian -117°) and interpolated to a square grid (grid interval = 0.4 km) by means of a routine based on the principle of minimum curvature (Briggs, 1974). Because both surveys were flown at a nominal height of 305 m above the ground surface (305 m drape), only the magnetic base levels of the surveys were adjusted to bring them onto a common datum. The survey grids were then merged by smooth interpolation across a one-kilometer-wide buffer zone along survey boundaries and contoured at an interval of 20 nanoteslas (nT).

The small "plus" symbols indicate possible locations of abrupt lateral changes in magnetization and may represent lithologic and/or structural boundaries. Their locations were determined as follows:

1) The total-field anomaly data were mathematically transformed into pseudogravity anomalies (Baranov, 1957); this procedure effectively converts the magnetic field to the "gravity" field that would be produced if all the magnetic material were replaced by proportionately dense material.

2) The horizontal gradient of the pseudogravity field was calculated everywhere by numerical differentiation.

3) Locations of locally steepest horizontal gradient ("plus" symbols) were determined by numerically searching for maxima in the horizontal gradient grid.

Boundaries between bodies having different densities are characterized by steep gradients in the gravity field and if the boundaries have moderate-to-steep dips (>45°) the maximum horizontal gradients will be located over the surface traces of the boundaries (Blakely and Simpson, 1986). Similarly, boundaries between bodies having different magnetizations are characterized by steep gradients in the pseudogravity field and therefore the procedure described above can be used to locate these boundaries.

REFERENCES

Baranov, V., 1957, A new method for interpretation of aeromagnetic maps: Pseudo-gravimetric anomalies: Geophysics, v. 22, p. 359-383.

Blakely, R.J., and Simpson, R.W., 1986, Approximating edges of source bodies from magnetic or gravity anomalies: Geophysics, v. 51, p. 1494-1496.

Briggs, I.C., 1974, Machine contouring using minimum curvature: Geophysics, v. 39, p. 39-48.

Gastil, Gordon, Diamond, Judith, Knaack, Charles, Walawender, Michael, Marshall, Monte, Boyles, Carolyn, Chadwick, Burton, and Erskine, Bradley, 1990, The problem of the magnetite/ilmenite boundary in southern and Baja California: *in* Anderson, J.L., ed., The nature and origin of Cordilleran magmatism, Geological Society of America Memoir 174, p. 19-32.

Jachens, R.C., Simpsen, R.W., Griscom, Andrew, and Mariano, John, 1986, Plutonic belts in southern California defined by gravity and magnetic anomalies (abs.): Geological Society of America Abstracts with Programs, v. 18, p. 120.

Rogers, T.H., 1965, Geologic map of California, Santa Ana sheet: California Division of Mines and Geology, scale 1:250,000.

Todd, V.R., Shaw, S.E., Jachens, R.C., Kimbrough, D.L., Girty, G.H., and Hammarstrom, J.M., 1991, The El Cajon 30'x60' quadrangle, southern California: A geologic history from Early Mesozoic continental growth to modern rift-transform tectonics (abs.): Geological Society of America Abstracts with Programs, v. 23, p. A479.

U.S. Geological Survey, 1983, Aeromagnetic map of the Salton Sea area, California: U.S. Geological Survey Open-File Report 83-664, scale 1:250,000.

U.S. Geological Survey, 1990, Aeromagnetic map of parts of the San Diego, Santa Ana, and adjacent 1° x 2° quadrangles, California: U.S. Geological Survey Open-File Report 90-206, scale 1:250,000.