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

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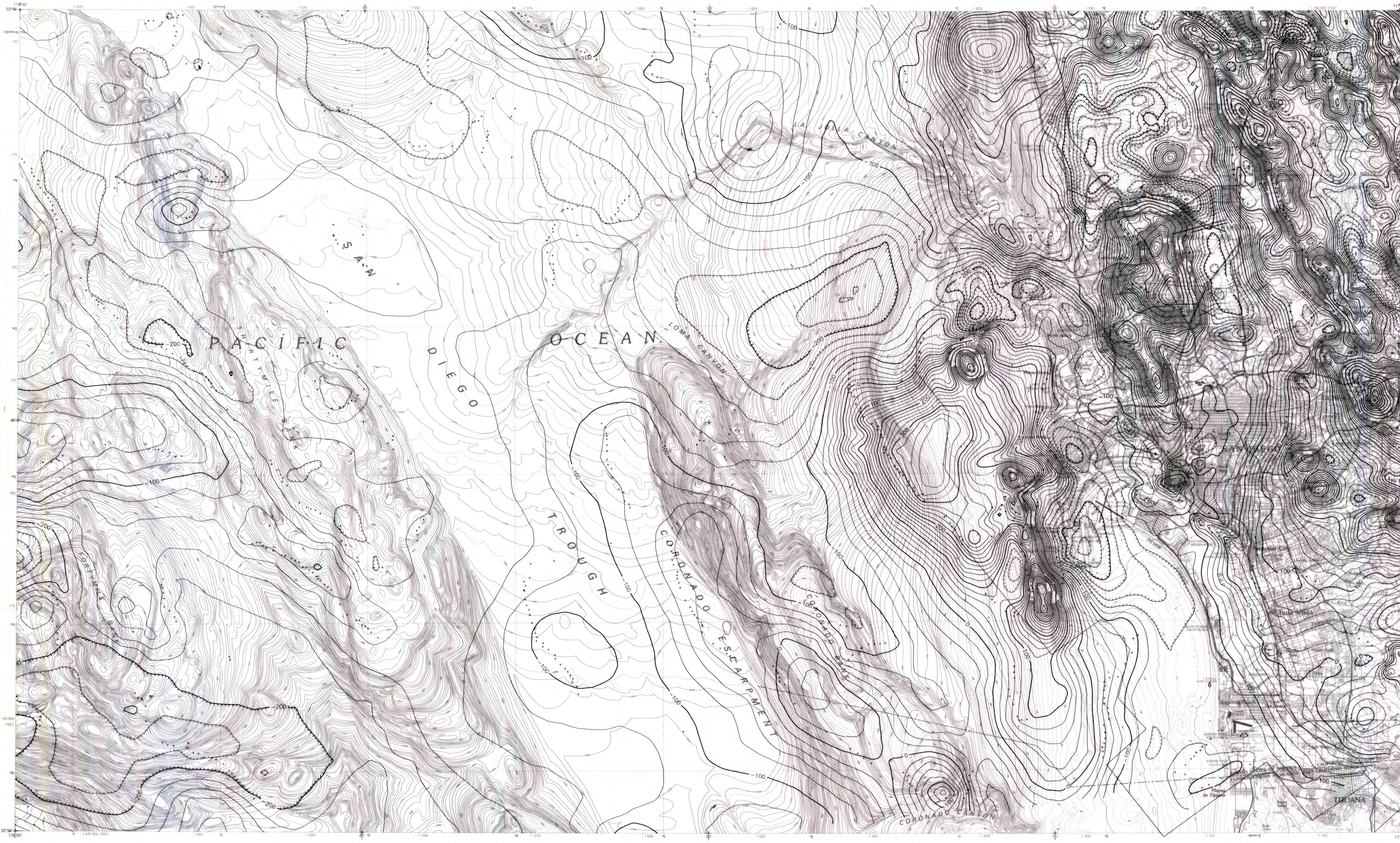
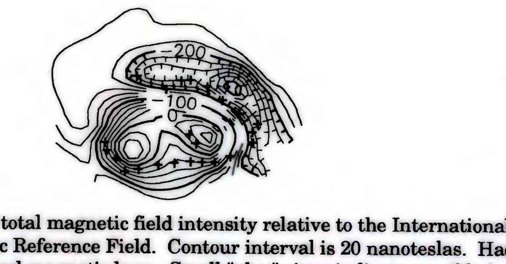
93-564

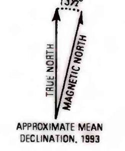


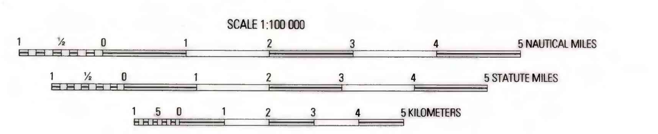


Contours of total magnetic field intensity relative to the International Geomagnetic Reference Field. Contour interval is 20 nanoteslas. Hachures indicate closed magnetic lows. Small "plus" signs indicate possible locations of boundaries between regions of different magnetizations (see accompanying text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

Base from U.S. Geological Survey, 1979
Bathymetry Added, 1988

Universal Transverse Mercator Projection





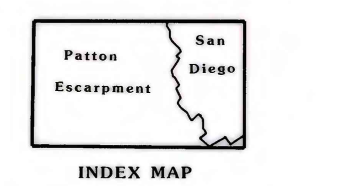
CONTOUR INTERVAL 50 METERS

BATHYMETRIC CONTOUR INTERVAL 10 METERS SUPPLEMENTARY CONTOUR INTERVAL 2 METERS

AEROMAGNETIC MAP OF THE SAN DIEGO 1:100,000-SCALE QUADRANGLE, CALIFORNIA-BAJA CALIFORNIA NORTE

By V.E. Langenheim and R.C. Jachens

1993



INDEX MAP

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 San Diego 1:100,000-scale quadrangle, California-Baja California Norte 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, dioritic, or ultramafic 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 onshore part of the San Diego quadrangle, magnetic minerals are concentrated mainly in the Mesozoic plutonic rocks of the Peninsular Ranges batholith (Strand, 1962; Jachens and others, 1986; Gastil and others, 1990). Numerous local magnetic highs and lows over the onshore area reflect both lateral variations of magnetization within the plutonic rocks and the juxtaposition of magnetic plutonic rocks against weakly or non-magnetic volcanic and sedimentary rocks. Plutonic rocks probably continue in the subsurface some distance offshore, but other sources for the offshore magnetic anomalies possibly include Tertiary volcanic rocks and older metaigneous rocks (Vedder and others, 1974).

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 San Diego 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 low lying just north of the northern edge of the body.

The striking contrast in magnetic anomaly pattern between the onshore and offshore parts of the map is caused by three factors: differences in original survey specifications; depth of burial of magnetic sources; and geology. First, because of different survey specifications, data available for the offshore area are more sparsely distributed than those for the onshore area (data points roughly every 1.5-2.0 km for the offshore area compared to every 0.2-0.8 km for the onshore area). The difference in data distribution over the two areas results in a smoother map offshore. Second, many of the onshore magnetic bodies crop out whereas those offshore lie under the water and, in some cases, beneath nonmagnetic submarine deposits. Thus the offshore magnetic sources lie farther below the effective measurement surface than do many of the onshore magnetic bodies. The greater vertical distance to the offshore magnetic sources causes the offshore magnetic anomalies to be smoother and lower in amplitude than onshore anomalies from comparable magnetic sources. Finally, because different rock types generally contain different amounts of magnetic minerals, pronounced changes in geology typically are associated with changes in magnetic anomaly pattern. Although contrasts in geology between the onshore and offshore areas probably account for most of the difference in map pattern, the importance of contributions from the other two factors remains to be evaluated quantitatively.

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 San Diego quadrangle.

TABLE 1.--Aeromagnetic survey specifications

Survey	Year flown	Flight elevation (Above ground surface)	Flight Line Spacing	Flight Line Direction	Reference
Offshore Southern California	1961	760 m[1]	1.6 km	NE/SW	Langenheim and others, 1993
San Diego	1989	305 m	0.8 km	NE/SW	U.S. Geological Survey, 1990

[1]estimated flight elevation

Data from the San Diego survey were taken directly from original digital tapes provided by the contractor. The International Geomagnetic Reference Field, updated to the date that the survey was flown, was subtracted from this survey to yield a residual magnetic field. The Offshore Southern California (OSC) survey was manually digitized from maps provided by Shell Oil Company to produce a digital data set (see Langenheim and others, 1993 for a detailed description of the methods used).

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). To insure compatibility of the two surveys during the final merging process, the OSC survey was analytically continued downward (Cordell, 1985) to an effective height of 305 m above the land or sea surface; the magnetic base levels of the surveys were adjusted to bring them onto a common datum. To do so, a comparison of the OSC with the merged California aeromagnetic data set (Roberts and Jachens, 1993) and profile E-E' of Bromery and others (1960) indicated that, in addition to a base level change, a regional tilt (-1.22 nT/km north; -0.81 nT/km east) needed to be subtracted from the OSC. The survey grids were then merged by smooth interpolation across a one- to two-kilometer-wide buffer zone along survey boundaries and contoured at an interval of 20 nanotesla (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 they produce and if the boundaries have moderate-to-steep dips (>45°), locally 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.

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