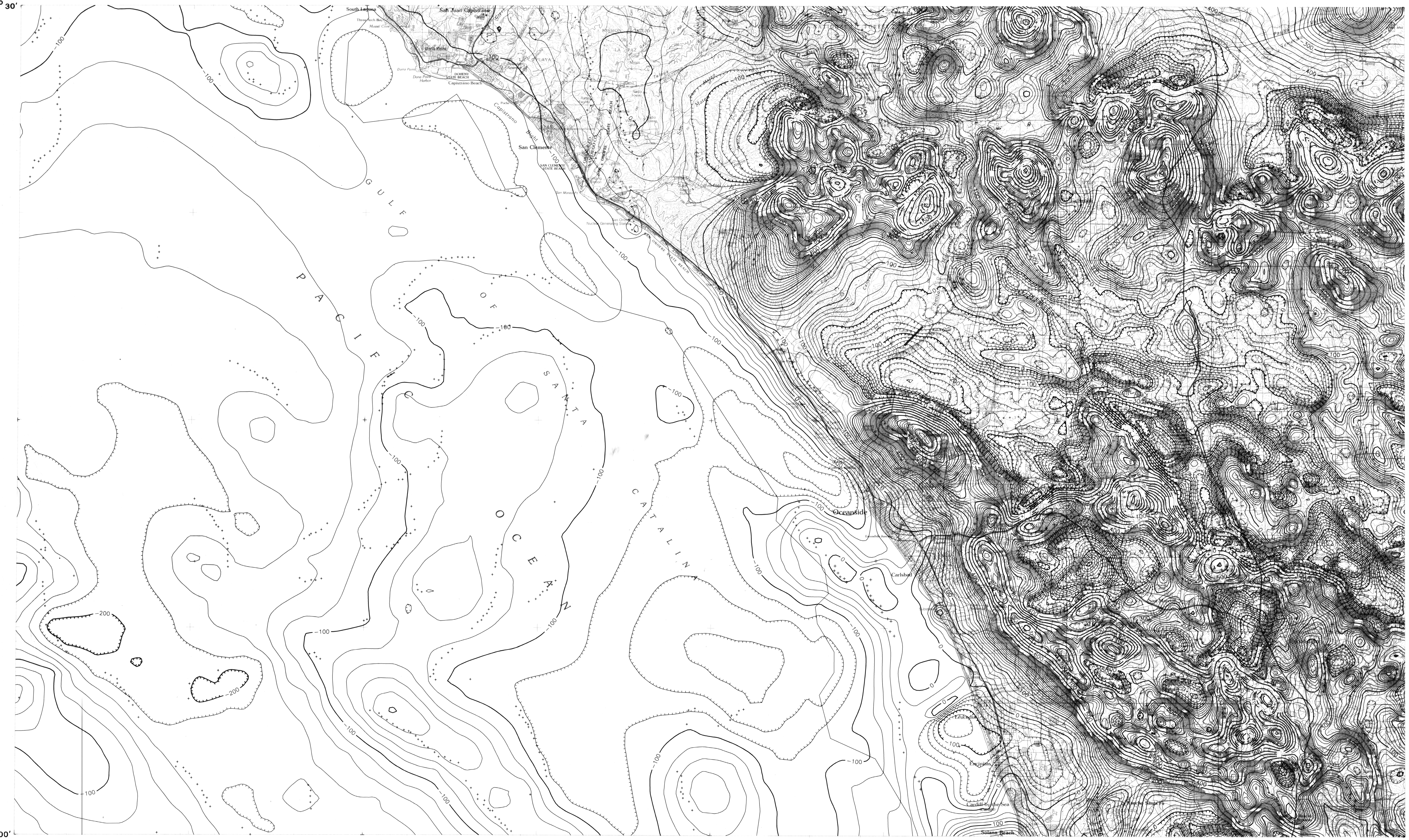
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN FILE REPORT
94-599

118° 00'    117° 00'
33° 30'




33° 00'

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

TRUE NORTH
MAGNETIC NORTH
14°
APPROXIMATE MEAN DECLINATION, 1994

SCALE 1:100 000
1 ½ 0 1 2 3 4 5 NAUTICAL MILES
1 ½ 0 1 2 3 4 5 STATUTE MILES
1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL OF BASE 50 METERS


Index of Aeromagnetic Surveys

# AEROMAGNETIC MAP OF THE OCEANSIDE 1:100,000-SCALE QUADRANGLE, CALIFORNIA

By

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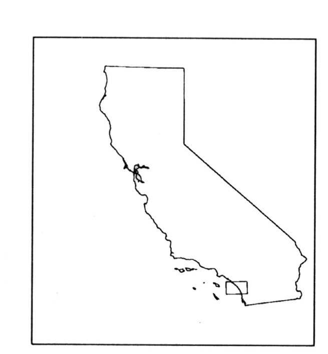
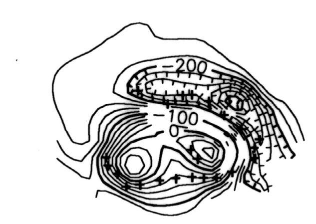
1994



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 Oceanside 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 Oceanside quadrangle, magnetic minerals are concentrated mainly in the Mesozoic plutonic rocks of the Peninsular Ranges batholith (Rogers, 1966). The profound difference in map pattern between the western offshore and eastern onshore portions of the map primarily reflects a fundamental change in rock type, although differences in spacing of flight lines over the onshore and offshore areas, and differences in the depth of burial of magnetic sources in the two areas also affect the pattern. Basement rocks that have been dredged from the ocean bottom consist primarily of blueschist (Vedder and others, 1974) that is essentially non-magnetic. Tertiary volcanic rocks may cause some of the weak magnetic anomalies over the offshore area. The onshore part of the quadrangle is underlain by magnetite-rich, mafic plutons of the western part of the Peninsular Ranges batholith (Jachens and others, 1986; Gastil and others, 1990). The magnetic anomaly pattern of numerous local highs and lows in the eastern part of the map indicates a wide range of magnetizations in the igneous source rocks. These magnetic plutonic rocks may continue offshore as much as 10 km in the southern half of the map, but because they are buried beneath water and non-magnetic sedimentary rocks (and, therefore, are deeper), the anomalies they produce are smoother and lower in amplitude than those over their exposed onshore counterparts. Deep burial of the magnetic source rocks probably is also the reason that the westernmost onshore magnetic anomaly (west of longitude 117° 30' W) is smoother and lower in amplitude than the anomalies farther east.

At the scale of this map, most magnetic anomalies bear a direct and somewhat intuitive 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 Oceanside 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.

## 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 Oceanside quadrangle. All of the onshore area is covered by a single survey (U.S. Geological Survey, 1990).

TABLE 1

| Survey | Year Flown | Flight Elevation (Above ground surface) | Flight Line Spacing | Flight Line Direction |
|---|---|---|---|---|
| Offshore Southern California (Langenheim, and others 1993) | 1961 | 760 m* | 1.6 km | NE/SW |
| San Diego (U.S. Geological Survey, 1990) | 1989 | 305 m | 0.8 km | NE/SW |

* flight elevation estimated

Data from the San Diego survey were taken directly from original digital tapes provided by the contractors. The International Geomagnetic Reference Field (IGRF), updated to the dates that the survey was flown, was subtracted from this survey to yield a residual magnetic field. The Offshore Southern California survey was hand digitized from maps provided by Shell Oil Company to produce a digital data set (for more information, see Langenheim and others, 1993).

Data from the surveys were transformed to a 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 principal of minimum curvature (Briggs, 1974). To insure compatibility of the two surveys during the final merging process, the Offshore Southern California 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 Offshore Southern California survey 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 Offshore Southern California survey in order to approximately remove the IGRF. The survey grids were then merged by smooth interpolation across a 1- to 2-km-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 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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