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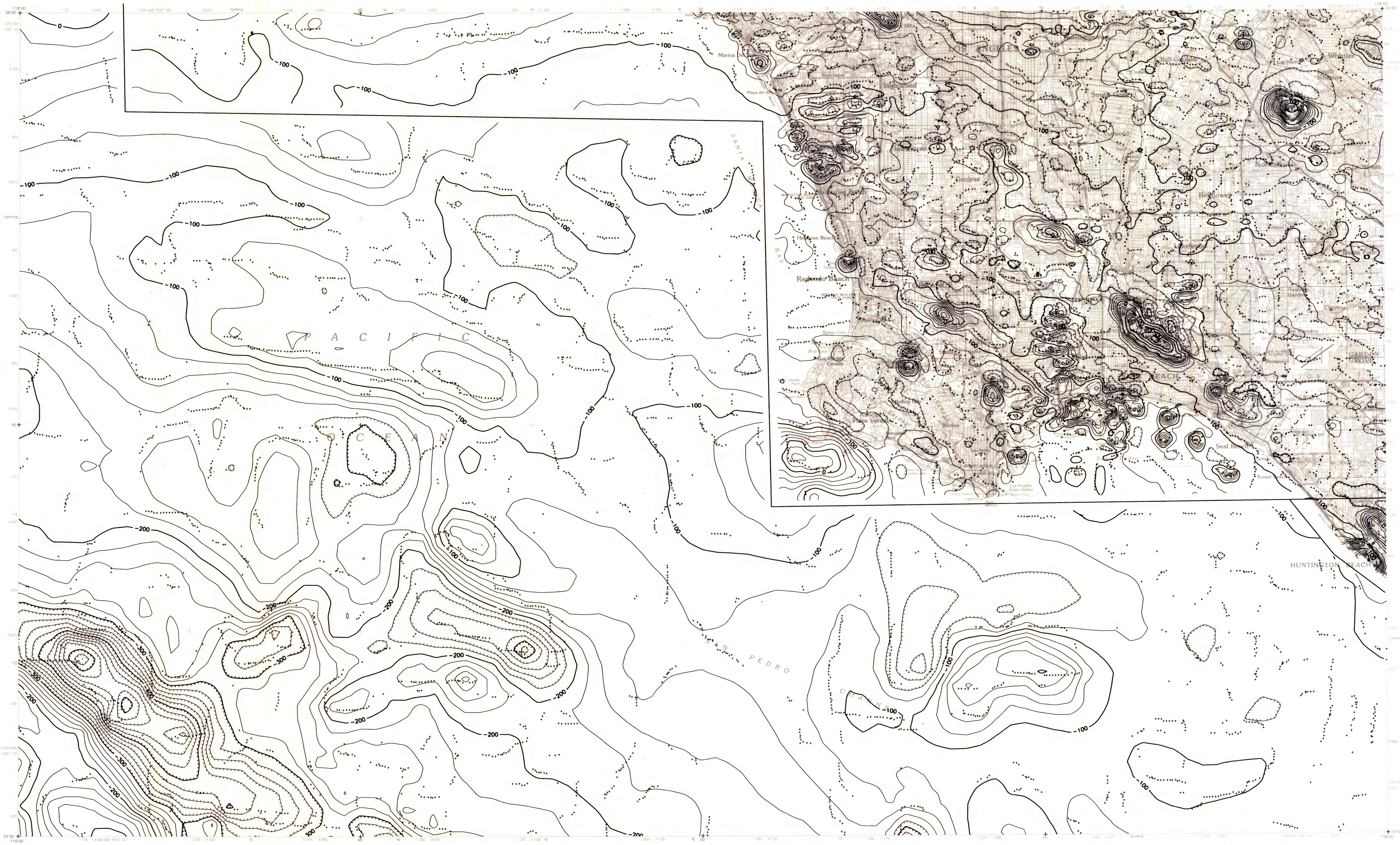
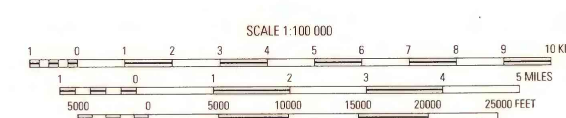
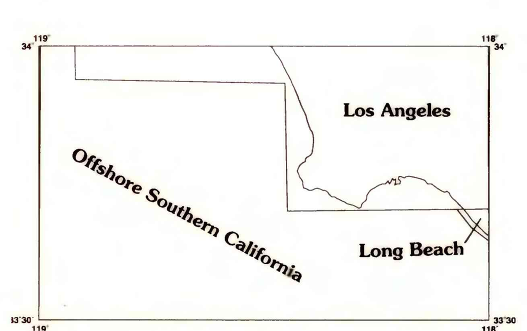


Base from U.S. Geological Survey, 1981.
Universal Transverse Mercator projection.





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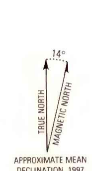

AEROMAGNETIC MAP OF THE LONG BEACH 1:100,000-SCALE QUADRANGLE, CALIFORNIA

By

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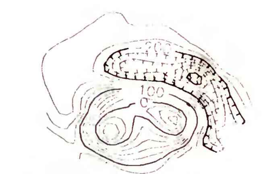
1996

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 Long Beach 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 or structural 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.

The Long Beach quadrangle, in terms of its magnetic field, is unique among the quadrangles in SCAMP, in that virtually all the geologic bodies that produce magnetic anomalies in this quadrangle are concealed beneath non-magnetic sedimentary deposits, water, or both. One possible exception is the Tertiary intrusive rock exposed on the Palos Verdes Peninsula (Jennings, 1962), although even here the identification of a specific magnetic anomaly that can be related to the exposed geology is difficult. Broad, low-amplitude anomalies (>10 km wide) over the onshore area (e.g., trending northwest from lat 33° 40', long 118° 0') reflect magnetic rocks in the deeply-buried basement of the Los Angeles basin that may be related to Cretaceous plutonic rocks exposed farther southeast in the Peninsular Ranges (Langenheim and Jachens, 1993). Offshore, likely sources for the anomalies include (1) Tertiary volcanic or intrusive rocks, (2) saussurite gabbros within the Catalina terrane, or (3) mafic basement rocks of the Nicolas terrane. Volcanic rocks have been found at lat 33° 35', long 119° 0' and may be responsible in part for producing the northwest-trending, positive anomaly there, but another possible source is the ophiolite basement of the Nicolas terrane. The boundary between the Catalina and Nicolas terranes is approximately located along the anomaly (Vedder, 1991; Langenheim and others, 1994) and furthermore, the edge of this anomaly, as defined by maxspots (see below) corresponds with a northwest-trending concentration of seismicity (Goter and others, 1994).

Short wavelength (widths of 1-2 km), high amplitude anomalies onshore are closely associated with active or abandoned oil fields, or with manmade structures. Prominent anomalies associated with oil fields include the nearly circular anomaly over the Santa Fe Springs field (lat 33° 56' N., long 118° 5' W.), and the northwest-trending linear anomalies over the Signal Hill (lat 33° 48' N., long 118° 10' W.) and Dominguez Hills (lat 33° 52' N., long 118° 15' W.) fields. The closely spaced, deeply-penetrating well-casings present in these oil fields are likely the dominant source of these anomalies, but contributions from other anthropogenic or natural sources associated with the oil fields cannot be ruled out. Examples of strong anomalies over manmade structures include those over the Long Beach harbor facilities (lat 33° 45' N., long 118° 12' W.), the oil tank farm near El Segundo (lat 33° 55' N., long 118° 25' W.), and the east-west-trending linear anomaly over the Los Angeles International Airport (lat 33° 57' N., long 118° 25' W.).

The contrast in magnetic anomaly pattern between the onshore and offshore parts of the map is caused by at least two factors: differences in the original survey specifications and depth of burial of magnetic sources. First, because of different survey specifications, data available for the offshore survey are more sparsely distributed than those for the onshore area. The difference in data distribution over the two areas results in a smoother map offshore. Second, many of the onshore sources are caused by manmade objects at the ground surface whereas those offshore lie under water and, in some cases, beneath a mantle of nonmagnetic submarine deposits. Thus, the offshore sources lie farther below the effective measurement surface than do many of the onshore sources and the resulting offshore anomalies are characterized by longer wavelengths and smaller amplitudes.

DATA SOURCES AND REDUCTIONS

Total-field magnetic data from three separate surveys (table 1, index map) were used to construct the aeromagnetic map of the Long Beach quadrangle.

TABLE 1

Survey	Year Flown	Flight Elev. Above ground	Flight Line Spacing	Flight Line Direction
Long Beach (Andreason and others, 1964)	1959	150 m	1.6 km	N/S
Los Angeles (U.S. Geological Survey, 1996)	1994-6	305 m	0.8 km	N/S
Offshore Southern California (Langenheim (and others, 1993)	1961	760 m*	1.6 km	NE/SW

* flight elevation estimated

Data from the Los Angeles survey (U.S. Geological Survey, 1996) were taken directly from original digital tapes provided by the contractor. 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). The Long Beach survey was hand digitized from the published aeromagnetic map (Andreason and others, 1964), with data sampled at the intersections of the flight-lines and the contours (contour interval 20 nanoteslas).

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 principle of minimum curvature (Briggs, 1974). To insure compatibility of the three 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, and the Long Beach survey was analytically continued upward to the same effective height. The magnetic base levels of the surveys were then 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. Although removing this regional tilt brought the Offshore Southern California survey into reasonable accord with the onshore surveys south to the Mexican border, a mismatch remains in the fit between the offshore survey and the onshore surveys in the Long Beach quadrangle. This mismatch is most obvious in the western half of the quadrangle, where it reaches as much as 60 nT. The Los Angeles and Long Beach survey grids were then merged by smooth interpolation across a 1-km-wide buffer zone along the boundary between the two surveys, but because of the mismatch between the onshore and offshore surveys, a buffer zone with no data was left along the boundary of the offshore survey. The final grids were contoured at an interval of 20 nT.

The small "plus" symbols indicate possible locations of abrupt lateral changes in magnetization and may represent lithologic 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 pseudogravity field was continued upward a distance of 1.0 km and subtracted from the original pseudogravity field (this procedure emphasizes those parts of the pseudogravity field that are caused by the shallow parts of the magnetic bodies, thus those parts most closely related to the mapped geology).

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

4) 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.

REFERENCES

Andreason, G.E., Pitkin, J.A., and Petrafeso, F.A., 1964, Aeromagnetic map of the Long Beach-Santa Ana area, California: U.S. Geological Survey Geophysical Investigations Map GP-464, scale 1:48,000.

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.

Bromery, R.W., Emery, K.O., and Balsley, J.R., Jr., 1960, Reconnaissance airborne magnetometer survey off southern California: U.S. Geological Survey Geophysical Investigations Map GP-211, scale 1:1,000,000.

Cordell, Lindrith, 1985, Techniques, applications, and problems of analytical continuation of New Mexico aeromagnetic data between arbitrary surfaces of very high relief [abs.]: Proceedings of the International Meeting on Potential Fields in Rugged Topography, Institute of Geophysics, University of Lausanne, Switzerland, Bulletin no. 7, p. 96-99.

Goter, S.K., Oppenheimer, D.H., Mori, J.J., Savage, M.K., and Masse, R.P., 1994, Earthquakes in California and Nevada: U.S. Geological Survey Open-File Report 94-647, scale 1:1,000,000.

Jennings,C.W., 1962, Geologic map of California, Long Beach sheet: California Division of Mines and Geology, scale 1:250,000.

Langenheim, V.E., and Jachens, R.C., 1993, Nature of basement rocks under the Los Angeles basin, southern California, as inferred from aeromagnetic data: GSA Abstracts with Programs, v. 25, p. 66.

Langenheim, V.E., Halvorson, P.F., Castellanos, E.L., and Jachens, R.C., 1993, Aeromagnetic map of offshore southern California east of the Patton Escarpment: U.S. Geological Survey Open-File Report 93-520, scale 1:500,000.

Langenheim, V.E., Jachens, R.C., Bohannon, R.G., and Geist, E.L., 1994, Aeromagnetic map of the Southern California Borderland east of the Patton Escarpment: Geological Society of America Abstracts with Programs, v. 26, p. 65.

Roberts, C.W., and Jachens, R.C.,1993, Draped aeromagnetic map of California--A new tool for regional structural and tectonic analysis [abs.]: EOS, Transactions, American Geophysical Union, v. 74, no. 16, p. 379.

U.S. Geological Survey, 1996, Aeromagnetic map of parts of the Los Angeles, Long Beach, and adjacent 1° x 2° quadrangles, California: U.S. Geological Survey Open-File Report in prep., scale 1:250,000.

Vedder, J.G., 1991, Regional geology and petroleum potential of the southern California borderland *in* Scholl, D.W., Grantz, Arthur, and Vedder, J.G., eds., Geology and Resource Potential of the Continental Margin of Western North America and Adjacent Ocean Basins--Beaufort Sea to Baja California: American Association of Petroleum Geologists Memoir 52, p. 403-447.