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

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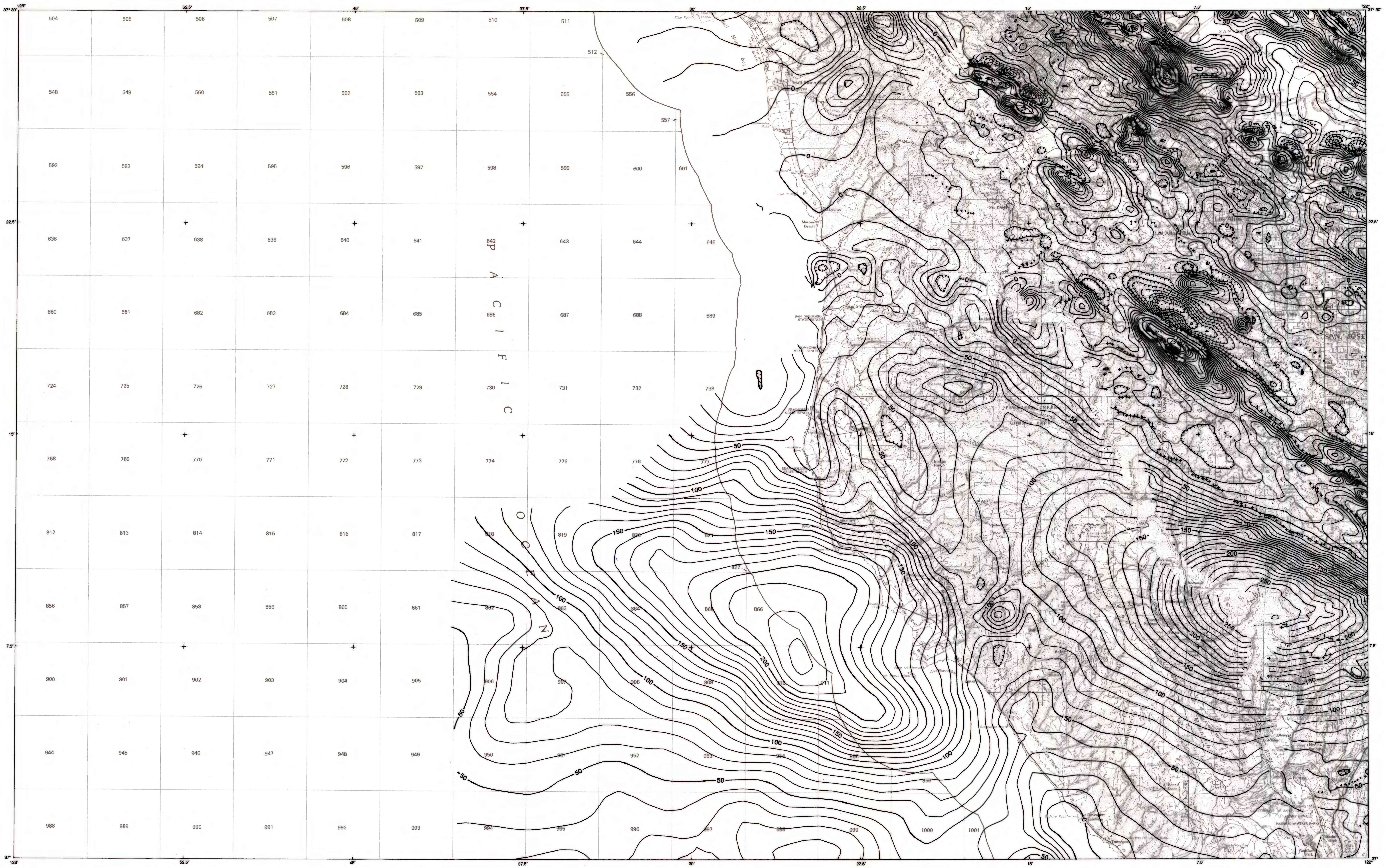
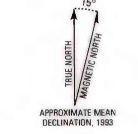
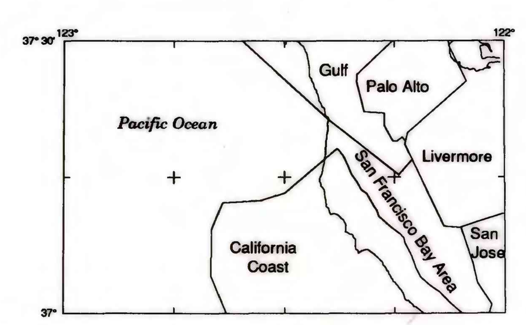
93-688



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





Index to aeromagnetic surveys
(See table 1 in text)

SCALE 1:100 000

KILOMETERS

MILES

FEET

TOPOGRAPHIC CONTOUR INTERVALS 10 AND 50 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

AEROMAGNETIC MAP OF THE PALO ALTO 1:100,000 QUADRANGLE, CALIFORNIA

By
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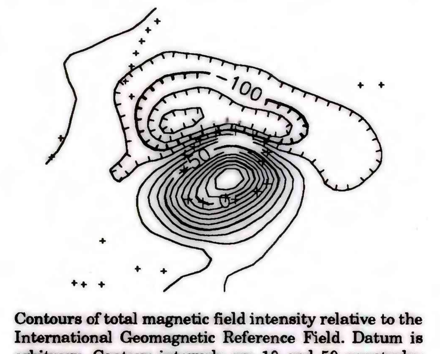
1993



Contours of total magnetic field intensity relative to the International Geomagnetic Reference Field. Datum is arbitrary. Contour intervals are 10 and 50 nanoteslas (nT). Hachured contours indicate closed magnetic lows. Small "plus" signs indicate possible locations of boundaries between regions of different magnitizations (see accompanying text for explanation).

INTRODUCTION

The accompanying aeromagnetic map is part of the San Francisco Bay area National Geologic Mapping Project and is intended to promote further understanding of the geology in the Palo Alto 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. The volume content of magnetic minerals often can be related to rock type, and abrupt spatial changes in the amount of magnetic minerals commonly mark lithologic boundaries. Bodies having mafic or ultramafic composition tend to produce the most intense magnetic anomalies, but such a generalization must be applied with caution because rocks with more felsic compositions also are capable of causing measurable magnetic anomalies.

The aeromagnetic map of the Palo Alto quadrangle can be divided, based on the character of the magnetic anomalies, into two regions separated by a northwest trending line extending from 37° 11' N., 122° 00' W. to 37° 30' N., 122° 20' W. and approximately coincident with the location of the San Andreas Fault (Wagner and others, 1990). Northeast of the San Andreas Fault, the magnetic field is dominated by narrow, linear northwest-trending anomalies mostly caused by sheets of mafic and ultramafic rock, probably associated with the Coast Range ophiolite (Brabb and Hanna, 1981; Langenheim and others, 1991; Jachens and Griscom, in press). Many of these magnetic sources are concealed beneath Cenozoic deposits. Three different magnetic sources account for most of the magnetic anomalies southwest of the San Andreas Fault. The large elliptical magnetic high centered at 37° 08' N., 122° 05' W. and its lower amplitude continuation to the northwest are caused by a deeply buried body, inferred to be composed of the magnetic gabbro (Hanna and others, 1972; Brabb and Hanna, 1981; Jachens and Griscom, in press). The short-wavelength (2-5 km) magnetic highs and lows in the area between the San Andreas Fault and gabbro anomaly reflect magnetic Tertiary volcanic rocks (Wagner and others, 1990), some of which have reverse remanent magnetization. The source of the large magnetic high that lies mostly offshore between Pigeon Point and Point Ano Nuevo is completely concealed and of unknown composition and affinity.

At the scale of this map, most magnetic anomalies are directly related 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 Palo Alto quadrangle (field inclination ~63° north) 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. An exception to the typical anomaly is the magnetic anomaly caused by a reversley magnetized body. Such a body will have a magnetic low over the southern part of the body and a high to the north.

DATA SOURCES AND REDUCTIONS

Total-field magnetic data from six separate surveys (table 1, index map) were used to construct the aeromagnetic map of the Palo Alto quadrangle. Data from all surveys except the Gulf survey are from original digital tapes provided by the contractors. Because primary digital data were not available for the Gulf survey, digital values were obtained from the contour map at locations where the contours intersected the flight lines. 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. *Aeromagnetic survey specifications*

Survey (reference)	Year Flown m	Flight Elevation (above ground) km	Flight Line Spacing	Flight Line Direction
California Coast (McCulloch and Chapman, 1977)	1975	610	1.6	NE-SW
Gulf (Gulf Oil Company, written commun.)	1954	915[1]	1.6	NE-SW
Livermore (U.S. Geological Survey, 1992)	1991	240-305	0.5	N 60° E
Palo Alto (Abrams and others, 1991b)	1990	240	0.4	NE-SW
San Francisco Bay Area (U.S. Geological Survey, 1974)	1973	915 [1]	1.6	N E-SW
San Jose (Abrams and others, 1991a)	1989	305	0.4	N 75° E

[1] survey flown at constant barometric elevation

Data from the Livermore, Palo Alto, and San Jose surveys were transformed to a Universal Transverse Mercator Projection (Base Latitude 0°, Central Meridian -123°) and interpolated to a square grid (grid interval = 0.25 km) by means of a routine based on the principal of minimum curvature (Briggs, 1974). Because these surveys were flown at approximately the same nominal height above the ground surface, 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).

Magnetic data from the other three surveys were collected at heights and line spacings significantly different from those of the Livermore, Palo Alto and San Jose surveys. Because magnetic measurements taken in these other surveys in general were either farther above or closer to the magnetic sources than in the Palo Alto, Livermore, and San Jose surveys, they could not be merged directly with the others. Furthermore, wide flightline spacing results in less detail between flight lines. Therefore, the data from these three surveys were transformed to a Universal Transverse Mercator Projection (Base Latitude 0°, Central Meridian -123°) and interpolated to a square grid (grid interval=1.0 km). The gridded data were either upward or downward continued numerically onto an irregular surface located 305 m above the ground surface following the techniques of Cordell (1985). These data were then merged with the other three surveys using the procedures described in the previous paragraph. Because these surveys are substantially less detailed than the Livermore, Palo Alto and San Jose surveys, we have left a narrow buffer zone on the map between areas covered by these surveys and those covered by the more detailed surveys.

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. Relative size of the "plus" symbol indicates relative magnitude of the maximum horizontal gradient.

Boundaries between bodies having different densities are characterized by steep gradients in the gravity field they produce. If the boundaries are shallow and have moderate-to-steep dips (>45°), the maximum horizontal gradients will be approximately 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.

We have included the possible boundary locations only in areas covered by the detailed surveys. The other surveys were judged to be too coarse to give reliable locations at a scale of 1:100,000.

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