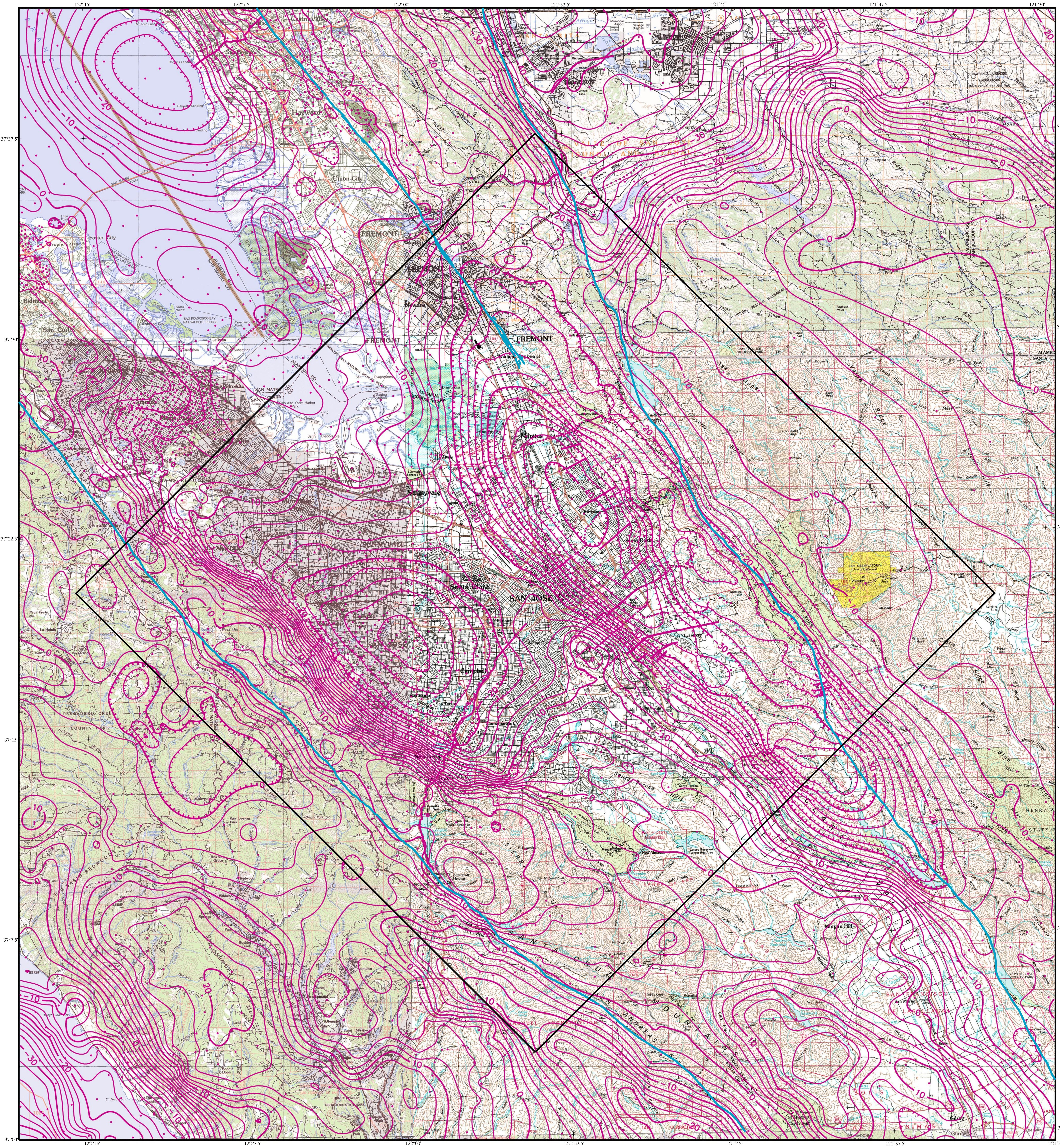
U.S. Department of the Interior
U.S. Geological Survey



Base from USGS Monterey, Palo Alto, San Francisco, San Jose and Stockton 1:100,000-scale maps dated 1978-1989.

SCALE 1:100,000

0 5 10 15 20 25 km

This gravity map covers the southern part of San Francisco Bay, the Santa Clara Valley and surrounding mountains. The underlying geology of part of the gravity map has been modelled in three-dimensions (Jachens and other, 2001).

Gravity methods

All gravity observations were converted to values of isostatic residual gravity using standard gravity corrections, including: (a) the earth tide correction, which accounts for tidal effects of the moon and sun; (b) instrument drift correction; (c) the latitude correction, which accounts for the variation of the Earth's gravity with latitude; (d) the free-air correction, which accounts for the variation in gravity due to station elevation relative to sea level; (e) the Bouguer correction, which accounts for the attraction of material between the station and sea level; (f) the curvature correction, which corrects the Bouguer correction for the effect of the Earth's curvature; (g) the terrain correction, which estimates the effect of topography to a radial distance of 166.7 km; and (h) the isostatic correction, which estimates long-wavelength variations in the gravity field inversely related to topography.

Conversion of LaCoste and Romberg gravity meter readings to milligals was made using factory supplied calibration constants and a secondary calibration factor determined from multiple gravity readings over the high-precision Mt. Hamilton calibration loop east of San Jose, Calif. (Barnes and others, 1969). Observed gravity values were based on a time-dependant linear drift between successive base readings and were referenced to the International Gravity Standardization Net 1971 (IGSN 71) gravity datum (Morelli, 1974, p. 18). The primary gravity base station was at the U.S. Geological Survey in Menlo Park.

Free-air gravity anomalies were calculated using the Geodetic Reference System 1967 formula for theoretical gravity on the ellipsoid (International Union of Geodesy and Geophysics, 1971, p. 60) and Swick's formula (1942, p. 65) for the free-air correction. Bouguer, curvature, and terrain corrections were added to the free-air correction to determine the complete Bouguer anomaly at a standard reduction density of 2.67 g/cm^3.

Terrain corrections, which account for the variation of topography near a gravity station, were computed using a three-part process: the innermost or field terrain correction, inner-zone terrain correction, and outer-zone terrain correction. The innermost or field terrain correction was estimated in the field, using a system of tables and charts, and typically extends to a radial distance of 53 or 68 m, Hammer (1939) zone C or Hayford and Bowie (1912) zone B, respectively.

Inner-zone terrain corrections were styled after the Hayford and Bowie (1912) system that divide the terrain surrounding a gravity station into zones and equal area compartments. For all the newer stations average elevations for each compartment were computed from a digital elevation model (DEM) derived from USGS 7.5 minute DEMs with a resolution of 10 m or 30 m. Inner-zone terrain corrections typically extended to a radial distance of 590 m, Hayford and Bowie (1912) zone D. Terrain corrections were then calculated based on the average estimated elevation of each compartment (Spielman and Ponce, 1984). Older stations were typically corrected to 590 m or 2290 m by estimating average compartment elevations on topographic maps.

Outer-zone terrain corrections, to a radial distance of 166.7 km, were computed using digitization derived from USGS 1:250,000-scale topographic maps and an automated procedure (Plouff, 1977; Godson and Plouff, 1988). Digital terrain corrections are calculated by computing the gravity effect of each grid cell using the distance and difference in elevation of each grid cell from the gravity station.

Finally, a regional isostatic gravity field was removed from the Bouguer field assuming an Airy-Heiskanen model for isostatic compensation of topographic loads (Jachens and Roberts, 1981). A sea level crustal thickness of 25 km, a crustal density of 2.67 g/cm^3, and a density contrast across the base of the model crust of 0.4 g/cm^3 was used and the computation was carried out for topography averaged over 3 by 3 minute compartments to a distance of 166.7 km from each station. Isostatic and terrain corrections beyond that distance were interpolated from a grid generated from Karki et al. (1961).

Gravity measurements made by the authors and their assistants were combined with older data to provide almost 5000 data points used for this gravity map. Locations for most of the new stations were obtained with a differential GPS system. Gravity values are expressed in milligals (mGal), a unit of acceleration where 1 Gal equals 1 cm/sec^2.

Faults are from Brabb and others, (1998a,1998b), Graymer and others (1996), Lienkaemper, (1992) and Wentworth and others (1998).

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Location of gravity measurement

−10 Isostatic residual gravity contours, interval 2 mGal

Fault

Boundary of 3-dimensional geologic model

125 years of science for America 1879–2004

ISOTATIC RESIDUAL GRAVITY MAP OF THE SANTA CLARA VALLEY AND VICINITY, CALIFORNIA

By

Carter W. Roberts, Robert C. Jachens, David A. Ponce and Victoria E. Langenheim

2004