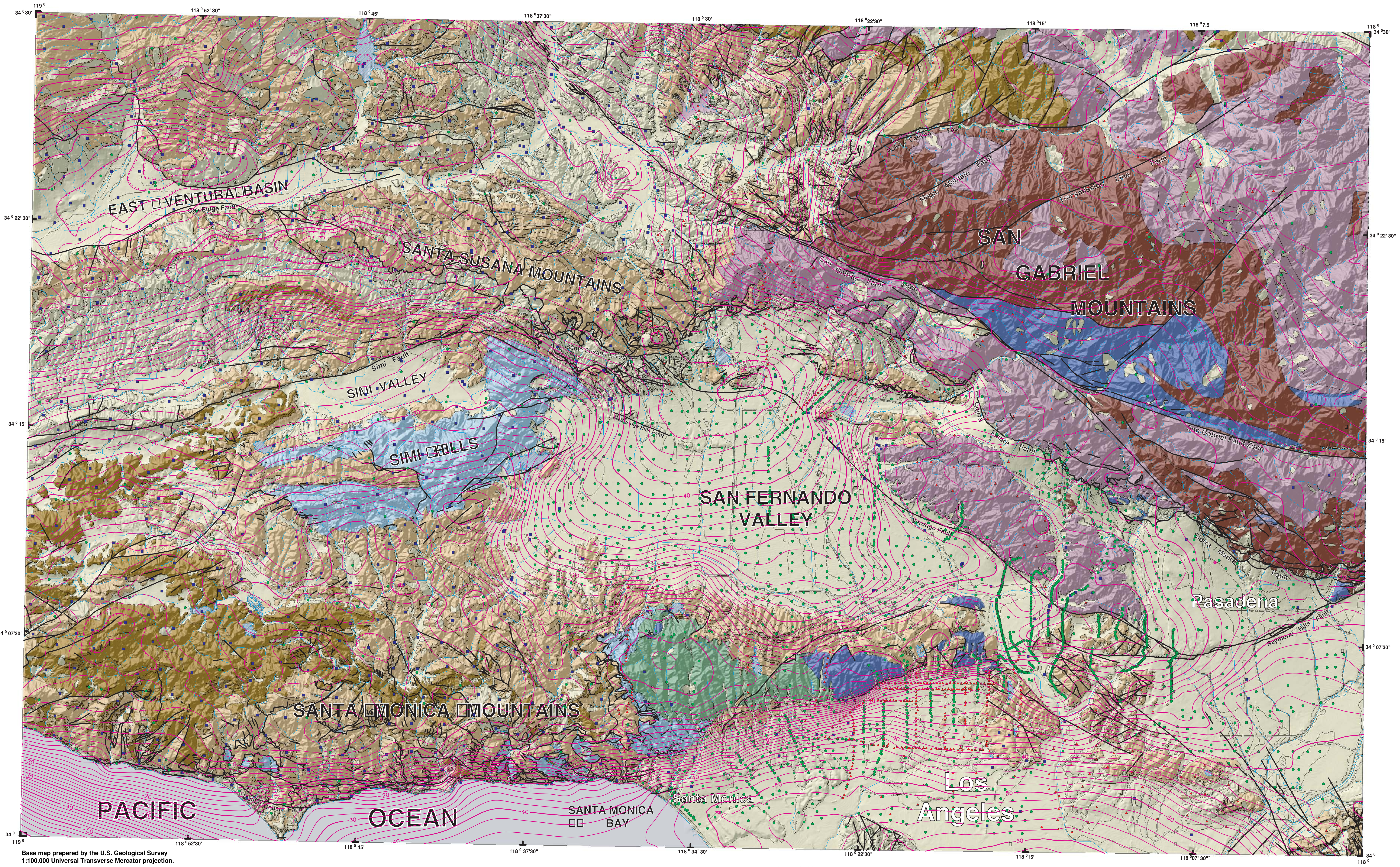
U.S. Department of the Interior
U.S. Geological Survey

Open-File Report 03-269
Isostatic Gravity Map of the Los Angeles 30'x60' Quadrangle, California

Version 1.0



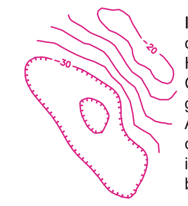
Base map prepared by the U.S. Geological Survey
1:100,000 Universal Transverse Mercator projection.

SCALE 1:100 000
MILES
KILOMETERS

EXPLANATION

GEOLOGY

- Quaternary Deposits
- Tertiary- Sedimentary
- Tertiary- Igneous
- Jurassic - Santa Monica Slate
- Water
- Cretaceous- Sedimentary
- Cretaceous- Igneous
- Mesozoic- Igneous
- Precambrian- Igneous and Metamorphic
- Faults



Isostatic gravity anomaly contours. Coutour interval, 2mGal. Hachures indicate gravity low. Contours were computer generated based on a 300-m grid. Although data have been edited, caution should be exercised when interpreting anomalies controlled by only a single station.

Gravity Station locations

- Defense Mapping Agency station
- U.S. Geological Survey pre 1990
- U.S. Geological Survey 1994-2001

Introduction

This isostatic residual gravity map is part of the Southern California Areal Mapping Project (SCAMP) and is intended to promote further understanding of the geology in the Los Angeles 30 x 60 minute quadrangle, California, by serving as a basis for geophysical interpretations and by supporting both geological mapping and topical (especially earthquake) studies. Local spatial variations in the Earth's gravity field (after various corrections for elevation, terrain, and deep crustal structure explained below) reflect the lateral variation in density in the mid- to upper crust. Densities often can be related to rock type, and abrupt spatial changes in density commonly mark lithologic boundaries.

The map shows contours of isostatic gravity overlain on a simplified geology including faults and rock types. The map is draped over shaded-relief topography to show landforms. Figure 1 shows the isostatic gravity as a color shade map.

The major features on the map are gravity lows associated with the Los Angeles basin, located at the south central part of the map, the San Fernando Valley, located in the center of the map and the East Ventura Basin located in the northwest part of the map. Major gravity highs on the map are associated with the San Gabriel Mountains in the northeast area of the map and the Santa Monica Mountains in the southwest to south central area. The Los Angeles basin is bounded on the northwest by a steep gravity gradient leading to high values in the Santa Monica Mountains

Isostatic residual gravity values within the Los Angeles quadrangle range from about -70 mGal over the East Ventura basin near the Santa Clara River (in the north western part of the map) to about 16 mGal near Hunt Canyon (centered over the Pacifico Mountain quadrangle) in the north-west part of the map.

Local, smaller gravity anomalies (less than about 2 mGal) may be due to local variations in geology, but could also be caused by a lack of sufficient gravity station coverage to completely define the anomaly or by single station errors. Therefore, caution should be exercised when interpreting small-scale gravity features.

Basement rocks exposed within the Los Angeles quadrangle include Mesozoic and Precambrian granitic and metamorphic rocks which are present in the mountainous areas of the map. These rocks produce many of the positive gravity anomalies. The highest gravity values measured on the Los Angeles sheet are over Mesozoic granitic rocks exposed on the southwestern edge of the San Gabriel Mountains (latitude 34° 52'30", longitude -118° 55'). Other high gravity values exist over exposures of Santa Monica Slate and over Cretaceous sedimentary rocks in the Simi Hills. These rocks are not very dense when compared to the Mesozoic igneous rocks, but produce gravity highs relative to those areas underlain by low-density younger rocks. Gravity lows characterize thick accumulations of low-density Tertiary sedimentary rocks and alluvial sediments that are located primarily in basins and valleys. However, with increasing depth of burial and age, the densities of these rocks may become indistinguishable from those of basement rocks.

Data Sources, Reduction, and Accuracy

Gravity data in the Los Angeles 1:100,000-scale quadrangle and vicinity include 428 gravity stations obtained by the U.S. Geological Survey from 1994 to June, 2001; 2536 stations from a previously published Bouguer Gravity Map of California--Los Angeles sheet compiled by W.F. Hanna and others, (1974); and 950 gravity stations obtained from the Defense Mapping Agency (written communication, 1994). Gravity stations collected by the U.S. Geological Survey for the Los Angeles Regional Seismic Experiment line II (LARSE II) are also included (see Figure 1). More detailed information on recent U.S. Geological Survey data collection in the Los Angeles area is contained in Wooley and Langenheim (2001). The datum of observed gravity for this map is the International Gravity Standardization Net of 1971 (IGSN 71) as described by Morelli (1974); the reference ellipsoid used is the Geodetic Reference System 1967 (GRS67; International Association of Geodesy and Geophysics, 1971).

The observed gravity data were reduced to free-air anomalies using standard formulas (e.g. Telford and others, 1976). Bouguer, curvature, and terrain corrections to a radial distance of 166.7 km) were applied to the free-air anomaly at each station to determine the complete Bouguer anomalies at a standard reduction density of 2.67 g/cm^3 (Plouff, 1977). An isostatic correction was then applied to remove the long-wavelength effect of deep crustal and/or upper mantle masses that isostatically support regional topography. The isostatic correction assumes an Airy-Heiskanen model (Heiskanen and Vening-Meinesz, 1958) of isostatic compensation; compensation is achieved by varying the depth of the model crust-mantle interface, using the following parameters: a sea-level crustal thickness of 25 km, a crust-mantle density contrast of 0.40 g/cm^3, and a crustal density of 2.67 g/cm^3 for the topographic load. These parameters were used because (1) they produce a model crustal geometry that agrees with seismically determined values of crustal thickness for central California, (2) they are consistent with model parameters used for isostatic corrections computed for the rest of California (Roberts and others, 1990), and (3) changing the model parameters does not significantly affect the resulting isostatic anomaly (Jachens and Griscom, 1985). The computer program ISOCOMP (Jachens and Roberts, 1981) directly calculates the attraction of an Airy-Heiskanen root by summing the attraction of individual mass prisms making up the root and thus calculating the isostatic correction; the resulting isostatic residual gravity values should reflect lateral variations of density within the mid- to upper crust.

The main sources of error are inaccurate terrain corrections and/or inaccurate elevations. Errors associated with terrain corrections may be 5 to 10 percent of the value of the total terrain correction. The average error based on the average terrain correction (2.48 mGal) is thus about 0.2 mGal, but in the most rugged areas of the San Gabriel Mountains, the individual errors may be as large as 3.2 mGal. Errors resulting from elevation uncertainties are probably less than 0.5 mGal for most of the data because the majority of the stations are at or near benchmarks and spot and surveyed elevations, which are accurate to about 0.2 to 3 m. Measurements for which elevations were controlled by contour interpolation are expected to have errors of up to 1.2 mGal. The significance of errors resulting from elevation is greater in mountainous areas, where elevations vary over a relatively short distance, than in the flatter valleys and deserts. In general, the total uncertainties for the data shown on the map are estimated to be less than 2 mGal (or one contour interval), although in many areas the data are considerably more accurate.

Acknowledgments

We would like to thank Doug Morton and the Southern California Areal Mapping Project for providing funding for the creation of this map. We would also like to acknowledge and thank Seth Stiles for help in collecting gravity data within the Los Angeles 30' x 60' quadrangle. The map benefited from reviews by David Ponce (U.S. Geological Survey, Menlo Park, CA).

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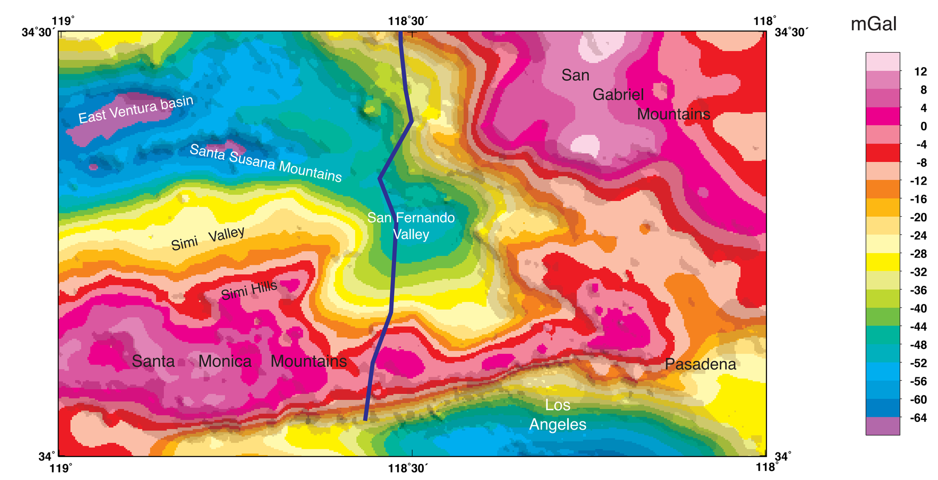
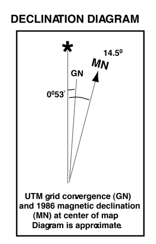


Figure 1. Color-shaded contour map of isostatic gravity for the Los Angeles 30 x 60 minute quadrangle. The contour interval is 4 mGal. The blue line is the location of the LARSE II transect.

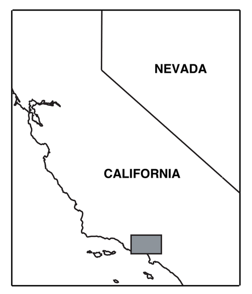


ISOSTATIC GRAVITY MAP WITH SIMPLIFIED GEOLOGY OF THE LOS ANGELES 30 x 60 MINUTE QUADRANGLE

By

R.J. Wooley, R.F. Yerkes, V.E. Langenheim, and F.C. Chuang

2003



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