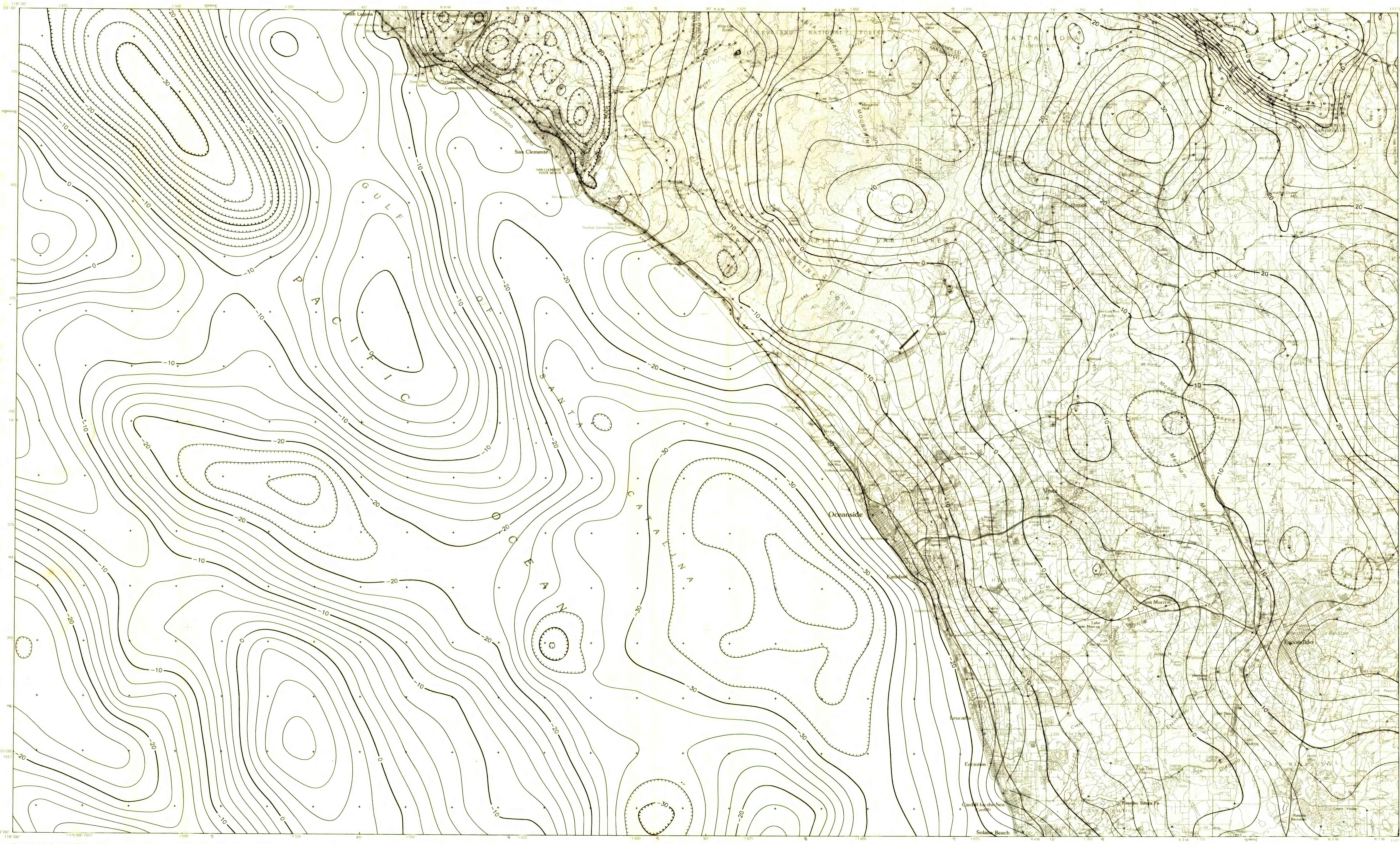
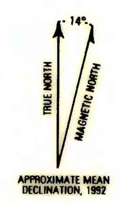
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN FILE REPORT
93-247



Base from U.S. Geological Survey, 1982

Universal Transverse Mercator projection



SCALE 1:100 000

KILOMETERS

MILES

FEET

CONTOUR INTERVAL 50 METERS

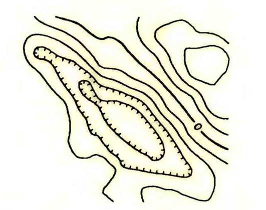
QUADRANGLE LOCATION

ISOTATIC RESIDUAL GRAVITY MAP OF THE OCEANSIDE 1:100,000-SCALE QUADRANGLE, CALIFORNIA

By

V.E. Langenheim and R.C. Jachens

1993



Gravity anomaly contours. Contour interval 2 milligals. Hachures indicate closed lows. Contours were computer generated based on an 800 m by 800 m grid derived from scattered gravity data. Although the data have been edited, caution should be exercised when interpreting anomalies controlled by only a single gravity station.

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Gravity station obtained from University of California at Riverside.

+

Gravity station collected by the U.S. Geological Survey. Offshore stations provided by L.A. Beyer.

▽

Gravity station obtained from the Defense Mapping Agency.

△

Gravity station collected by the California Division of Mines and Geology.

○

Gravity station obtained from A.G. Hull.

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 Oceanside 1:100,000-scale quadrangle, California, by serving as a basis for geophysical interpretations and by supporting both geological mapping and topical, SCAMP-related studies. Local spatial variations in the Earth's gravity field (after various corrections for elevation, terrain, and deep crustal structure explained below) reflect the distribution of densities in the mid- to upper crust. Densities often can be related to rock type, and abrupt spatial changes in density commonly mark lithologic boundaries.

High-density basement rocks exposed within the Oceanside quadrangle generally include metamorphic rocks and Mesozoic plutonic rocks present in the mountainous areas of the quadrangle. Plutonic bodies of mafic composition, such as gabbro or diorite, are usually responsible for gravity highs whereas felsic plutons where juxtaposed against denser metamorphic or igneous rocks commonly cause local gravity lows. Alluvial sediments, usually located in the valleys, and Tertiary sedimentary rocks are characterized by low densities. However, with increasing depth of burial and age, the densities of these rocks may become indistinguishable from those of basement rocks.

Isostatic residual gravity values within the Oceanside quadrangle range from about -37 mGal over an offshore sedimentary basin of the continental margin (southern central region of map) to about 32 mGal near Red Mountain in the northeastern corner of the map. The lowest onshore gravity values of about -29 mGal occur over the sedimentary fill of the Capistrano Embayment.

Data Sources, Reductions, and accuracies

Gravity data in the Oceanside 1:100,000-scale quadrangle and vicinity include 355 gravity stations obtained by Shawn Biehler and his students at University of California at Riverside, 12 stations from the California Division of Mines and Geology, 27 gravity stations from the Defense Mapping Agency (written commun., 1982), 149 stations obtained from A.G. Hull (written communication, 1991) and 274 U.S. Geological Survey stations. Offshore gravity data were provided by L.A. Beyer (written communication, 1982) in the form of gridded gravity values derived from shiptrack lines. More detailed information on data sources and base stations is contained in Sikora and others (1993). 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, 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 distance of 166.7 km; Plouff, 1977) 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. 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 for onshore stations are inaccurate elevations and/or inaccurate terrain corrections. 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 (1.42 mGal) is thus about 0.1 mGal, but in the most rugged areas of the Santa Margarita Mountains, the individual errors may be as large as 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 bench marks 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. 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.

References

Heiskanen, W.A., and Vening-Meinesz, F.A., 1958, The Earth and its gravity field: New York, McGraw-Hill Book Company, Inc., 470 p.

International Union of Geodesy and Geophysics, 1971, Geodetic reference system 1967: International Association of Geodesy Special Publication no. 3, 116 p.

Jachens, R.C., and Griscom, A., 1985, An isostatic residual gravity map of California--A residual map for interpretation of anomalies from intracrustal sources in Hinze, W.J., ed., The Utility of Regional Gravity and Magnetic Anomaly Maps: Society of Exploration Geophysicists, Tulsa, Oklahoma, p. 347-360.

Jachens, R.C., and Roberts, C.W., 1981, Documentation of a Fortran program, `ISOCOMP', for computing isostatic residual gravity: U.S. Geological Survey Open-File Report 81-574, 26 p.

Morelli, Carlo. (ed.), 1974, The International gravity standardization net 1971: International Association of Geodesy Special Publication no. 4, 194 p.

Plouff, Donald, 1977, Preliminary documentation for a FORTRAN program to compute gravity terrain corrections based on topography digitized on a geographic grid: U.S. Geological Survey Open-File Report 77-535, 45 p.

Roberts, C.W., Jachens, R.C., and Oliver, H.W., 1990, Isostatic residual gravity map of California and offshore southern California: California Division of Mines and Geology, Geologic Data Map No. 7, scale 1:750,000.

Sikora, R.F., Langenheim, V.E., Biehler, Shawn, Beyer, L.A., and Chapman, R.H., 1993, Principal facts and base station descriptions for gravity data compiled for the Santa Ana 1° by 2° quadrangle, California: U.S. Geological Survey Open-File Report 93-217A, 63 p.

Telford, W.M., Geldart, L.O., Sheriff, R.E., and Keyes, D.A., 1976, Applied Geophysics: New York, Cambridge University Press, 960 p.