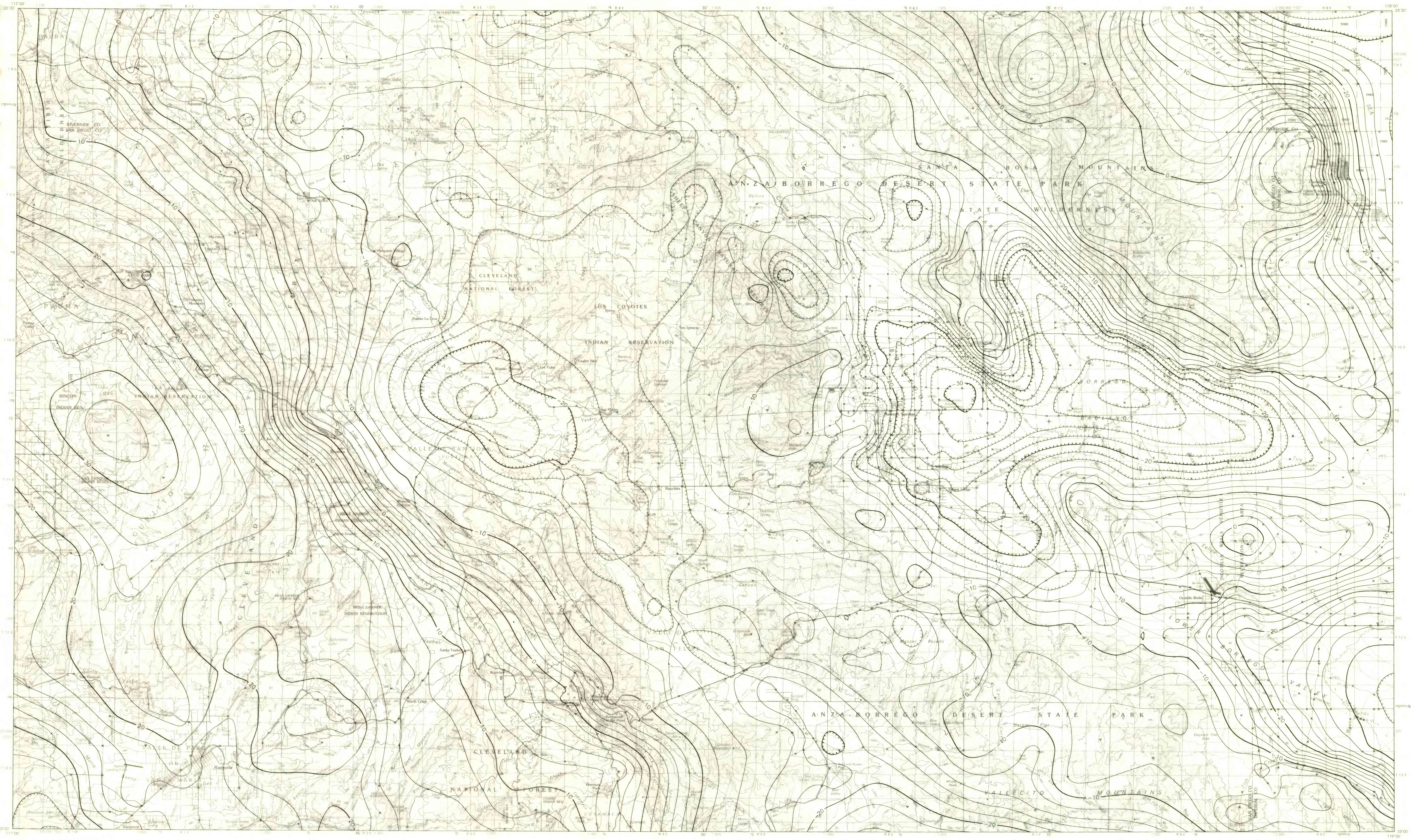
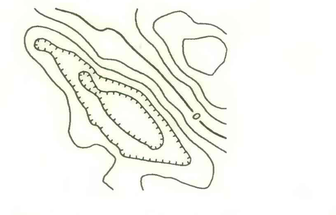
OPEN FILE REPORT
93-246

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



Base from U.S. Geological Survey, 1982



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.

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 Borrego Valley 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 Borrego Valley 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 Borrego Valley quadrangle range from about -30 mGal over the sedimentary basins of the Salton Sea area (northeast corner of map) and Borrego Valley to about 32 mGal near Rodriquez Mountain in the western part of the map.

Data Sources, Reductions, and accuracies

Gravity data in the Borrego Valley 1:100,000-scale quadrangle and vicinity include 859 gravity stations obtained by Shawn Biehler and his students at University of California, Riverside, 92 gravity stations from the Defense Mapping Agency (written communication, 1982) and 76 U.S. Geological Survey stations. 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 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 (3.46 mGal) is thus about 0.3 mGal, but in the most rugged areas of the Santa Rosa Mountains, the individual errors may be as large as 5 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

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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.

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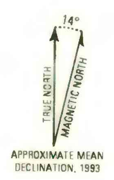
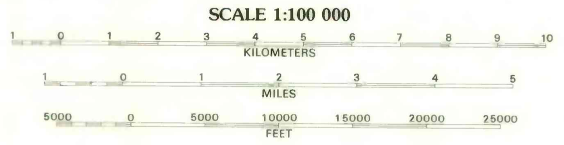
Sikora, R.F., Langenheim, V.E., Biehler, Shawn, Beyer, L.A., and Chapman, R.H., 1993, Principal facts and base station descriptions for gravity data compiled for the Santa Ana 1° by 2° quadrangle, California: U.S. Geological Survey Open-File Report 93-217A, 63 p.

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



APPROXIMATE MEAN DECLINATION, 1993

SCALE 1:100 000



CONTOUR INTERVAL 40 METERS
SUPPLEMENTARY CONTOUR INTERVAL 20 METERS

Quadrangle Location

ISOSTATIC RESIDUAL GRAVITY MAP OF THE BORREGO VALLEY 1:100,000-SCALE QUADRANGLE, CALIFORNIA

BY

V.E. Langenheim and R.C. Jachens

1993