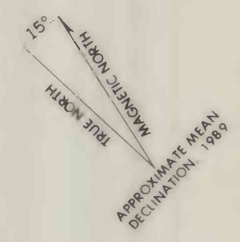
Base from U.S. Geological Survey, Bakersfield, 1971; Fresno, 1971; Monterey, 1976; San Luis Obispo, 1969. Scale 1:250,000. Transverse Mercator Projection, central meridian at 120.5°W.



SCALE 1:250 000

5 0 5 10 15 20 MILES

5 0 5 10 15 20 25 30 KILOMETERS

ISOSTATIC RESIDUAL GRAVITY CONTOUR INTERVAL 2 MGAL
BASE TOPOGRAPHY CONTOUR INTERVAL 200 FEET

ISOSTATIC RESIDUAL GRAVITY MAP, PARKFIELD REGION

AVERAGE TOPOGRAPHY, ISOSTATIC RESIDUAL GRAVITY, AND AEROMAGNETIC MAPS OF THE PARKFIELD REGION, CALIFORNIA

By

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1989

Isostatic Residual Gravity Map

Explanation

This map was prepared from approximately 8,468 observations of the Earth's gravity field in the vicinity of Parkfield, California. The majority of observations were supplied by the Defense Mapping Agency (DMA) of the Department of Defense. Additional observations came from the U.S. Geological Survey gravity data base for California (Snyder and others, 1982), and data north of latitude 36° 15' are exclusively from this second source. Closely spaced observations (with surveyed elevations) across Cholame Valley were made by the authors. All observed gravity values are referenced to the International Gravity Standardization Net (IGSN71) datum described by Morelli (1974).

In order to isolate anomalies in the gravity field, observed values were compared with values predicted from an ideal earth model that contains features known to cause variations in gravitational attraction. The gravitational variations caused by the Earth's shape and spin were predicted using the Geodetic Reference System 1967 (GRS67) formula for gravity on the reference ellipsoid (International Association of Geodesy, 1971). The dependence of gravity on the elevation of an observation above sea-level was predicted using the free-air correction formula given by Swick (1942). The gravitational attraction of topographic masses in the vicinity of an observation was predicted by calculating Bouguer, curvature, and terrain corrections (Swick, 1942). Finally, the gravitational attraction of compensating masses that isostatically support the topography was predicted using a local Airy-Heiskanen model of compensation. More information on some details of these corrections is provided in the following paragraphs.

Partial terrain corrections (for topography in an annulus with inner radius at 0.895 km and outer radius at 166.7 km) were computed for each observation site using a Fortran program of Plouff (1977). The data from U.S. Geological Survey sources were also corrected for terrain effects between 0 and 0.895 km (Hammer zones A-D) by using transparent templates placed on topographic maps. No such inner-zone corrections have been applied to the DMA data. As a result, some isolated anomalies appear in regions of rough topography because of the neglect of the inner zones. Such anomalies are commonly defined on the contour map by a single gravity observation and are mostly less than a few mGal in amplitude.

A Bouguer reduction density of 2.67 g/cm^3 for topographic features was used. The 2.67 g/cm^3 value is best suited for regions where topographic features are formed of crystalline rocks of "granitic" composition. In the Parkfield area, much of the topography, especially on the west side of the San Andreas fault, is underlain by Tertiary sedimentary units with densities substantially less that 2.67 g/cm^3. As a result, certain anomalies on the map appear to correlate with topographic features (e.g., high gravity values occur along some river valleys cut into Tertiary sedimentary units). Such anomalies would disappear if a more accurate reduction density were used. However, because of the difficulty in obtaining accurate density information, and because no single reduction density is appropriate for all topographic features in the region, we have chosen to use the standard density of 2.67 g/cm^3 to produce this map. Anomalies produced in areas where this choice is incorrect can best be treated at the modeling stage by incorporating bodies bounded above by the ground surface. Because many topographic features in the study area are controlled by geologic structures, some of which generate gravity anomalies, the problem of attributing anomalies to either incorrect reduction densities or geologic features of interest in the subsurface is not always an easy one, and users of these maps should be aware of this problem.

The isostatic correction was applied to the data in two parts. For compensating masses out to a radius of 166.7 km from a station the correction was calculated using a Fortran program of Jachens and Roberts (1981) and digitized topography described by Robbins and others (1973). For the region beyond 166.7 km, combined terrain and isostatic corrections were taken from the maps of Kärki and others (1961). Isostatic model parameters used were: a density of 2.67 g/cm^3 for the topographic load, a depth of 25 km for the root beneath sea-level elevations, and a density contrast of 0.40 g/cm^3 across the bottom of the model root. These parameters were chosen because they yield a root geometry that is in fairly good agreement with the geometry of the Moho for much of California (Jachens and Griscom, 1985). Differences in isostatic residual anomalies caused by different choices for these parameters tend to be small and to vary slowly across an area of this size.

When the isostatic correction and the other corrections mentioned above are combined into a predicted gravity value, the difference between the observed gravity and the predicted gravity yields an anomaly called the isostatic residual gravity anomaly. Isostatic residual gravity anomaly maps are especially useful for separating gravity anomalies caused by geologic sources in the upper crust from broader wavelength anomalies generated by sources at greater depths that compensate the topographic loads.

To prepare this map, the irregularly spaced anomaly data were projected using a transverse mercator projection with central meridian at 120.5°W longitude, and then interpolated to a rectangular grid with 1 km grid spacing using a minimum curvature algorithm. The grid was then contoured at an interval of 2 mGal, and the contoured map was rotated counterclockwise by 48° to make the San Andreas fault approximately parallel to the map edges.

We estimate that most gravity observations in the combined data set have an accuracy better than a few tenths of a mGal. Uncertainty in the elevations of the observation sites above sea-level introduces an error into the predicted values. For observations made on benchmarks or along surveyed profiles, this error is probably less than a few tenths mGal. For elevations obtained from spot elevations on topographic maps, the error is usually less than 1 mGal. We estimate that even though we did not calculate inner-zone terrain corrections for many sites, the gravity anomaly values used to prepare this map are probably accurate to better than 2 mGal (1 contour interval) for more than 90 percent of the observations.

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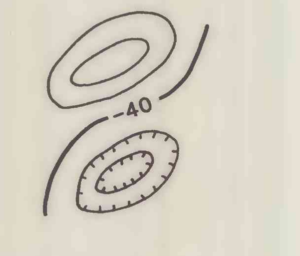

Gravity Anomaly Contours

Contours show isostatic residual gravity. Contour interval is 2 mGal, with darker index contours at 10 mGal interval. Hachured contours indicate closed gravity lows.

LOCATION MAP