Base from U.S. Geological Survey, 1962

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA—1986—G86039

SCALE 1:250,000

5 0 5 10 15 20 MILES

5 0 5 10 15 20 25 30 KILOMETERS

CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTAL CONTOURS AT 100 FOOT INTERVALS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

EXPLANATION

GRAVITY CONTOURS—Contour interval 2 milligals. Hachured contours indicate areas of low gravity closure. Dashed in areas of poor control.

PRIMARY BASE STATIONS

SECONDARY BASE STATIONS

GRAVITY STATIONS

DISCUSSION

This map is released in connection with new geologic mapping and resource analysis studies in the Winnemucca 1° by 2° quadrangle (T.G. Theodore, written commun., 1985). The Bouguer and isostatic gravity maps provide particular help in determining the thickness of the valley fill, the configuration of mafic and felsic intrusions, and in all studies related to mineral deposits.

This map augments the "Bouguer gravity map of Nevada - Winnemucca sheet" (Erwin, 1974) which was published with a contour interval of 5 mGal. A total of 694 additional gravity stations were collected by the U.S. Geological Survey, R.W. Grannell, and Don Schafer since 1974. All gravity data sets are listed under Sources of Gravity Data. The gravity datums of each of the 8 sources have been checked by reoccupying at least 3 stations of each source and adjusting each data set accordingly. Terrain and curvature corrections have been applied to all 1,915 gravity stations (only 5 stations were terrain-corrected on the previous map (Erwin, written commun., 1984)). Due to the new data, these corrections, and adjustments, the uncertainty in the complete Bouguer anomalies is for most stations less than 0.5 mGal (for some older data within 1 mGal) so that the decreased contour interval of 2 mGal is justified.

All gravity data have been adjusted to the 1971 IGSN (International Gravity Standardization Network) (Morelli, 1974) and reduced to the GRS 1967 reference ellipsoid (International Association of Geodesy, 1971). The primary base stations are Defense Mapping Agency Aerospace Center (DMA/AC) (formally called Aeronautical Chart and Information Center (ACIC)) base station #0474–1, Winnemucca airport, Nev., using a value of 979,810.48 mGal (Jablonski, 1974), and DMA/AC base station #2344–2, Battle Mountain airport, Nev., using a value of 979,754.79 mGal (Jablonski, 1974). Five secondary base stations were established by the author in August 1984 with an uncertainty of the gravity values of less than 0.1 mGal relative to the two primary base stations.

Terrain corrections were determined for all stations from the station outward to a distance of 166.7 km using elevations averaged over 0.25- by 0.25-minute compartments. These corrections were applied by the U.S. Geological Survey by operating on gridded digital terrain data using a procedure developed by Plouff (1977). Terrain corrections were determined manually for 55 stations to a radial distance of 590 m (Hayford-Bowie zones A–D) and for 11 of those stations to a radial distance of 1,280 m (Hayford-Bowie zones A–E) in the most rugged topography to increase the accuracy of these data. Earth-curvature corrections were applied, and a standard reduction density of 2.67 g/cm^3 was used to determine the complete (terrain-corrected) Bouguer anomaly values. Isostatic corrections to a radial distance of 166.7 km were computed using the AIRYROOT program (Simpson and others, 1983) which assumes local isostatic compensation according to the Airy-Heiskanen model. The parameters assumed for the Airy-isostatic model are 25 km for the sea-level crustal thickness, 2.67 g/cm^3 for the density of the topography above sea level, and 0.4 g/cm^3 for the density contrast between the lower crustal and the upper mantle material which has been displaced by the Airy-type mountain root (see Heiskanen and Vening Meinesz, 1958, p. 135–140). Published results (Karki and others, 1961) were used to determine the attraction of the root and the effect of surface topography beyond 166.7 km to the antipodes.

The case for applying isostatic corrections to Bouguer gravity data in mountainous terrain has most recently been presented by Jachens and Griscom (1985). In brief, the compensating masses (isostatic "roots") which support topographic loads produce large amplitude, long wavelength anomalies on regional Bouguer gravity maps. These anomalies, which are inversely correlated with regional topography, greatly obscure the shorter wavelength anomalies caused by bodies of geologic interest. Quantitative modeling of these short wavelength anomalies also becomes difficult in the presence of the topography-related regional field.

Figure 1 shows the regional isostatic field which has been removed from the Bouguer values to get the isostatic residuals.

The range in Bouguer anomalies is from –227 mGal in Pine Valley in the southeast corner of the Winnemucca quadrangle to –145 mGal near the Humboldt River in the northwest part of the quadrangle. The mean Bouguer anomaly, based on 1,951 gravity stations, is –182 mGal with a standard deviation of 14 mGal. Similarly, the range in isostatic residuals is from –32 mGal in Pine Valley to +25 mGal in the Tuscarora Mountains in the northeast part of the quadrangle, and the mean residual is –6 mGal with a standard deviation of 11 mGal. Thus, the Bouguer anomaly range of 82 mGal is reduced to 57 mGal, and the mean Bouguer anomaly increased by 176 mGal, by removing the isostatic field. The standard deviation of the mean isostatic residual (11 mGal) is a measure of the heterogeneity of rock densities in the upper crust, whereas the standard deviation of the mean Bouguer anomaly (14 mGal) results from a combination of geologic variance and the variation in crustal thickness associated with topographic loads.

A comparison of the Bouguer anomalies and isostatic residuals over major positive and negative mass anomalies (Table 1) indicates that the isostatic reduction serves to "normalize" the anomalies and provides some absolute basis for comparison. The negative anomalies have larger isostatic residuals than positive residuals by 10 mGal (about –29 versus about +19 mGal); however, this difference is reduced to near zero if taken relative to the mean isostatic residual.

The positive anomalies of the Tuscarora Mountains, Sulphur Spring Range, Sheep Creek Range, and Cortez Mountains are associated with the western oceanic assemblage composed of Paleozoic siliceous and volcanic rocks (Roberts, 1964; Roberts and others, 1967; Stewart and McKee, 1970; Stewart and Carlson, 1976). Mesozoic volcanic rocks and the western oceanic assemblage of siliceous and volcanic rocks cause the 14 mGal anomaly of the East Range.

The sediments causing the negative anomalies extend to depths between 1.5 and 2 km, assuming a density contrast of 0.5 g/cm^3 with the surrounding rocks. The depths of the valley fill in Pine Valley and Buena Vista Valley appear to be slightly shallower than the depth of Pleasant Valley although the isostatic residuals are lower. This can be caused by the narrowness of the Pleasant Valley.

The principal facts, accuracies, and sources of all gravity stations are discussed in detail in the U.S. Geological Survey report NTIS No. PB 85–235927, (Wagini, 1985).

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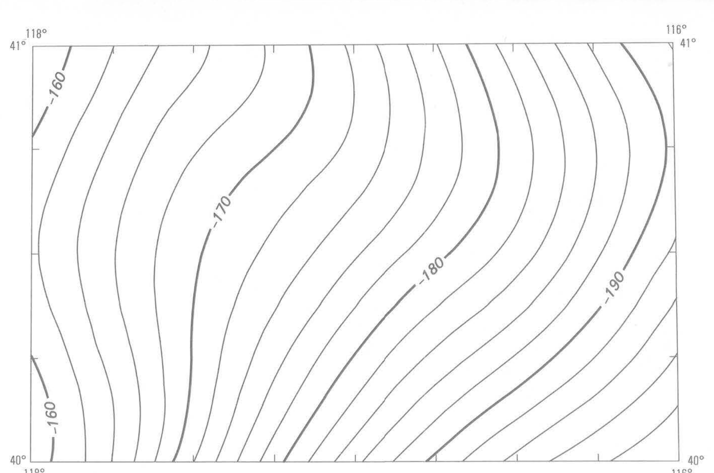

Figure 1.—Regional isostatic field of the Winnemucca 1° by 2° quadrangle. Contour interval 2 milligals.

Table 1.—*Comparison of Bouguer anomalies and isostatic residuals over major mass anomalies in the Winnemucca quadrangle.*

Name	Bouguer anomaly (mGal)	Isostatic residual (mGal)
	Positive anomalies	
Tuscarora Mountains	–161	+25
Sulphur Spring Range	–174	+22
Sheep Creek Range	–156	+18
Cortez Mountains	–173	+16
East Range	–148	+14
	Negative anomalies	
Pine Valley	–227	–32
Buena Vista Valley	–192	–31
Pleasant Valley	–197	–29
Reese River Valley	–204	–28
Grass Valley	–194	–27

INDEX MAP WITH PRIMARY BASE STATIONS.
W = Winnemucca, BM = Battle Mountain

SOURCES OF GRAVITY DATA

[DMA, Defense Mapping Agency; NBMG, Nevada Bureau of Mines and Geology; USGS, U.S. Geological Survey]

Source and year of survey	Number of stations	Symbol
USGS - A. Wagini (1984), G.A. Abrams (1984)	85	★, ▽
R.W. Grannell (1975-1973)	577	×
NBMG - J.W. Erwin (1964-1973)	142	+
Data from the DMA Gravity Library		
NBMG - J.W. Erwin (1964-1973)	546	○
USGS - Don Schafer (1982-1983)	32	□
DMA Hydrographic/Topographic Center (1967-1969)	6	✝
USGS - D.R. Mabey (1958-1960)	397	△, ◇
Geodetic Survey Squadron (1968-1972)	166	✖
Total	1,951	

Bouguer Gravity Anomaly Map

BOUGUER AND ISOSTATIC GRAVITY MAPS OF THE WINNEMUCCA 1° BY 2° QUADRANGLE, NEVADA

By

Alexander Wagini

1986

For sale by U.S. Geological Survey, Map Distribution, Box 25286, Federal Center, Denver, CO 80225