UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Principal facts for gravity data compiled for the Conterminous United States Mineral Appraisal Program, Tonopah 1- by 2-degree quadrangle, Nevada

by

Donald Plouff

1990

90-457-A Documentation (paper copy)
90-457-B Tables of principal facts (paper copy)
90-457-C Digital gravity data (diskette)

Open-File Report 90-457-A

Menlo Park, California
1990

CONTENTS

TABLES

ILLUSTRATIONS

INTRODUCTION

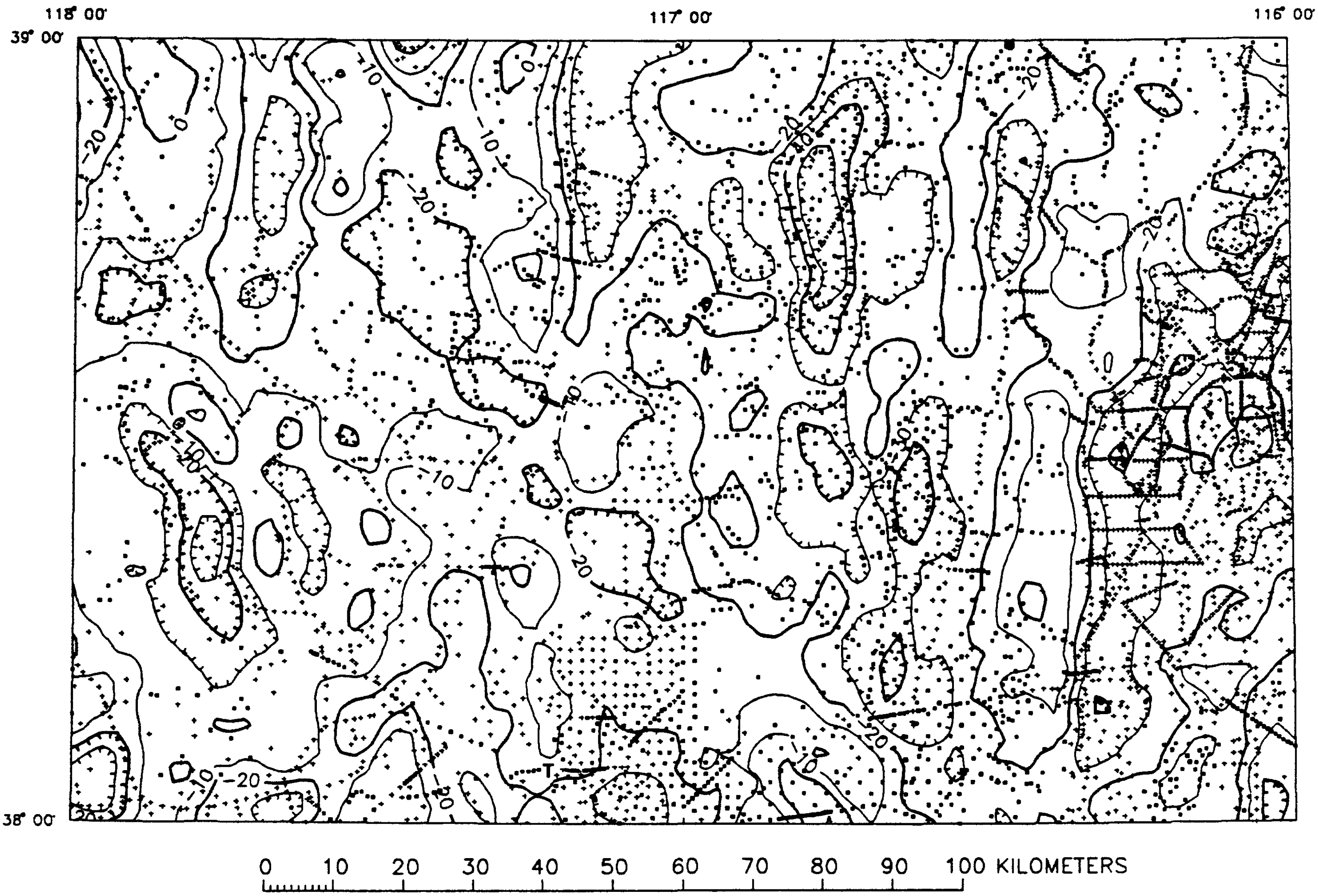
Principal facts for gravity data in the Tonopah 1- by 2-degree quadrangle are listed in six tables in Part B and six corresponding files on the diskette in Part C of this report. Parts B and C also include introductory descriptions to explain their format and contents. Principal facts include unique station names, geographic coordinates, elevations, values of observed gravity, accuracy codes, free air gravity anomalies, dates of last observation if known, inner terrain corrections, total terrain corrections, outer radii of inner terrain corrections, Bouguer gravity anomalies, values of isostatic residual gravity, and base stations if known.

The purpose of this study is to assemble a gravity data set that will form the basis for Bouguer gravity anomaly, isostatic residual, and derivative maps to be interpreted as part of a geologic assessment of the mineral resources of the Tonopah quadrangle. The Tonopah 1- by 2-degree quadrangle, Nevada, is located between lat 38 and 39 degrees N. and between long 116 and 118 degrees W. (fig. 1). This report lists previously unpublished principal facts for 90 gravity stations and principal facts for 4,185 gravity stations listed in previous reports (Peterson and Dansereau, 1976; Healey and others, 1980b; Saltus and others, 1981; and Bol and others, 1983). The latter data are listed again because many changes were made for locations, elevations, values of observed gravity, terrain corrections, and, consequently, gravity anomalies.

The data set obtained at the beginning of this study included gravity data at more than 6,000 data points. The data set was similar to that on a magnetic tape of 6,861 data points for the state of Nevada (Saltus, 1988, table 1), but most data points that caused obvious errors ("bullseyes") of gravity anomalies when contoured at an interval of 5 mGal were excluded from the latter data set. Many data points of the original data set were redundant or had significant errors associated with their locations, elevations, or observed gravity. Many erroneous data points were incorporated in a data set originally obtained from the National Geophysical Data Center (1984). Further refences to this gravity data set will be abbreviated as "the DMA data set."

The process of selecting and correcting principal facts in the initial data set was optimized by first discarding less reliable, nearly-coincident stations. Next, stations with elevations that substantially differed from interpolated digital elevations were identified on lists of elevation differences and associated contour plots. Doubtful data points were discarded, or their locations or elevations were corrected. Station names and elevations of initially accepted data points were computer-plotted directly on the latest topographic maps. Lists of only station names, locations, and elevations were keyed to a 5-digit, map-based arrangement so that, despite duplication or complexity of numbering or map-naming schemes, stations to be corrected or discarded could be readily identified. Data points that had the same station name or no name were assigned unique station names. Data points located near spot elevations or bench marks, near cultural features such as roads or marked section corners, and approximately arranged along regularly-spaced lines or grids generally were accepted with minor modifications. Uncertainty of locations or elevations for those data points were expressed by 3-digit accuracy codes. Other data points with locations that markedly disagreed with topography or culture and data points too closely spaced for their uncertainties of locations or consequent uncertainties of terrain corrections were discarded or were selectively retained. Locations of about 860 data points were re-digitized in order to improve registration with topographic maps published after the gravity data originally were compiled and to correct erroneous locations.

Contour plots of the difference between published terrain corrections associated with data collected by the U.S. Geological Survey before 1980 (Healey and others, 1980b) and digital terrain corrections using the present



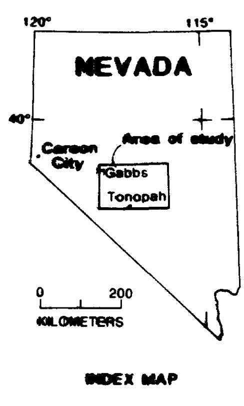


Figure 1.--Isostatic residual gravity map of Tonopah quadrangle. Contour interval, 10 mGal. Station locations are shown with two symbols. Combined accuracies of locations, elevations, and observed gravity are better at stations with plus symbols than those with square symbols. T, Tonopah.

terrain model showed irregularly-spaced anomalous areas. Inasmuch as files for the early terrain model and maximum distances, to which early inner terrain corrections were carried, were not found, new inner terrain corrections were estimated to a distance of 500 m by manual methods (using a station-centered, cylindrical-coordinate system) and were combined with digital outer terrain corrections based on the current terrain model. Data accuracy also was improved by determining manual terrain corrections that were not determined by Saltus and others (1981) for previous data points from the DMA data set.

The last criterion for rejecting or attempting to correct a data point was conspicuous disagreement ("bullseye") between the contoured gravity anomaly and anomalies at adjacent stations.

OBSERVED GRAVITY

The datum of observed gravity for stations listed in this report is the International Gravity Standardization Net of 1971 (IGSN-71) described by Morelli (1974). Two gravity base stations in the Tonopah quadrangle listed by the Defense Mapping Agency as part of a worldwide gravity network (Jablonski, 1974) are located at the Tonopah airport ("TONOPAH-J") and the town of Round Mountain ("ROUND MTN B"). Values of observed gravity at most local base stations (table 1) were established by U.S. Geological Survey ties to station TONOPAH-J, where the value of observed gravity is 979,462.25 mGal (Jablonski, 1974). The observed gravity at local gravity base stations and at other stations established before the adoption of IGSN-71 were adjusted to that value. For the purpose of data reduction, ROUND MTN B was treated as a local base station because ties by the U.S. Geological Survey to TONOPAH-J resulted in a value about 0.05 mGal lower than the published value. The difference of gravity values probably is an effect of a combination of instrument calibration differences and changes of site conditions such as subsidence and groundwater level. A total of 22 gravity stations near the north edge of the Tonopah quadrangle were tied to a base station at Austin, Nevada (Jablonski, 1974).

TERRAIN CORRECTIONS

Terrain corrections, the gravity effect of departures of the Earth's surface from a horizontal plane that passes through the station, were determined to distances of 500, 590, and 895 m by evaluating elevations and slopes within compartments bounded by radial lines and circles on templates (Hammer, 1939; and Campbell, 1980). The number of stations that were terrain corrected to these distances were 3,693, 510, and 72, respectively. Inner terrain corrections range to 6.3, 8.5, and 7.2 mGal and have average values and associated standard deviations of 0.2+/-0.7, 1.0+/-1.5, and 1.2+/-1.5 mGal, respectively. Terrain corrections, including the effect of the Earth's curvature, were determined in the remaining distance to 166.7 km by using a computer program that incorporates a model of topography digitized at intervals of 15 seconds, 1 minute, and 3 minutes (Plouff, 1977; Godson and Plouff, 1988). The terrain model was derived from digitization of topographic maps at scales of 1:250,000. The validity of the model was qualitatively confirmed by overlaying a computer-drawn plot of the terrain model on the Tonopah topographic map. The digital model was examined by contouring the difference between station elevations and interpolated model elevations (fig. 2). After correction for erroneous station elevations, elevation differences were attributed to low vertical and horizontal accuracy of topography mapped at a scale of 1:250,000. The quality of the present terrain model is excellent, inasmuch as only small areas show elevation errors that exceed 60 m (200 ft) (fig. 2). The error of gravity anomalies associated with the error of digital terrain model was minimized because the innermost parts of terrain corrections were estimated manually to distances of at least 500 m from each station on topographic maps at the largest available scales of 1:24,000 and 1:62,500.

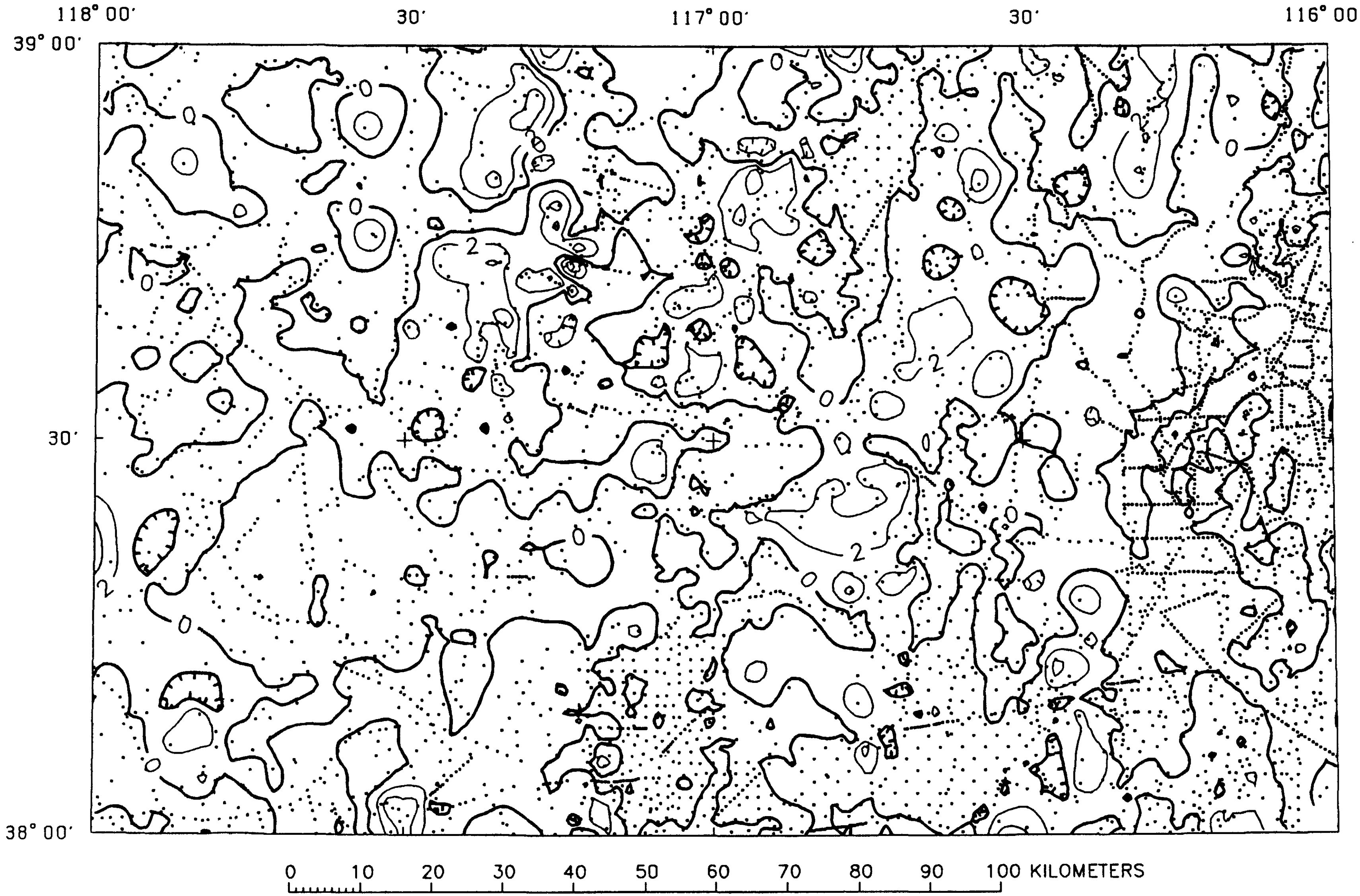


Figure 2.--Difference between elevations of accepted data points and linearly interpolated elevations from present digital terrain model. Contour interval, 100 ft (30 m). Contours are labeled in units of hundreds of feet, which are roughly equivalent to errors in units of milligals for gravity anomalies if manual terrain corrections were not done.

Data collected before 1984 lack field notes to calculate the effect of terrain to standard distances of 53 or 68 m from the stations. Another small error for the purpose of this regional compilation results from the choice of too large compartment sizes on inner terrain-correction templates for mountainous terrane, which was demonstrated by differences of terrain corrections as high as 0.2 mGal between adjacent template compartments. The error of each inner terrain correction is not expected to exceed 10% of the value of the inner terrain correction.

GRAVITY ANOMALIES

Theoretical values of gravity at station latitudes were determined by using the Geodetic Reference System 1967 formula (GRS-67) for normal gravity on the spheroid (International Association of Geodesy, 1971, p. 60). Without considering the mass of rocks to sea level, the theoretical value of gravity was adjusted to station elevations by using Swick's (1942, p.65) formula for the free-air correction. Free-air gravity anomalies then were calculated at the station locations by subtracting the theoretical gravity values from the observed gravity values. Complete Bouguer anomalies at a standard reduction density of 2.67 g/cm3 were determined by adding the Bouguer, Earth's-curvature, and terrain corrections to the free-air gravity anomaly. Formulas used to calculate gravity corrections were listed by Oliver (1980, p. 50). Isostatic corrections were estimated by using a computer program by Jachens and Roberts (1981). That program calculates the effect of Airy-Heiskanen isostatic compensation by using 3-minute topographic digitization. Parameters assumed for the isostatic model were 25 km for the normal crustal thickness, 2.67 g/cm3 for the density of the crust, and 0.4 g/cm3 for the contrast in density between the lower crust and the upper mantle. The effect of the Earth's curvature was not taken into account for the isostatic correction, so that an exact join could be made with the previously published gravity map of the Walker Lake quadrangle (Plouff, 1982; 1987) to the west. The curvature correction would add 1.1 mGal to the value of isostatic residual gravity at the station with the lowest elevation (1448 m asl) and 0.9 mGal at the highest gravity station (3588 m asl) in the quadrangle.

DATA COLLECTED BY U.S. GEOLOGICAL SURVEY AFTER LAST PRINCIPAL-FACTS REPORT

Principal facts for one previously unlisted data point collected in 1980 and 89 data points collected after publication of the principal-facts report by Bol and others (1983) are listed in table 1 in Parts B and C. A tide-corrected drift curve was prepared for gravity data collected in 1984 (fig. 3). The scatter of points forming drift curves shows the uncertainty of repeating gravity readings at stations superimposed on the effect of instrument drift. The range of daily drift did not exceed 0.1 mGal relative to base station TONSN. Inasmuch as data collected by the U.S. Geological Survey between 1980 and 1983 were re-reduced by the author, drift curves for data collected in 1980 and 1983 are included in a later section. Methods described by Barnes and others (1969) were used after 1979 to empirically revise calibration tables provided by gravity meter manufacturers.

U.S. GEOLOGICAL SURVEY DATA AT PREVIOUSLY LISTED STATIONS

Data collected for Department of Energy, Nevada Tectonic, and Nevada Cooperative programs

Fieldwork and data processing were supervised by D.L. Healey, Denver, Colo. A total of 2,509 data points (table 2 in Parts B and C) were accepted from principal facts listed by Healey and others (1980b). Gravity stations identified by the prefix, "TS", in that report originally were obtained from the DMA data set (table 6 in Parts B and C) and, hence, are not included in table 2. Data collected by A.H. Cogbill, Jr., which were listed by Healey and others (1980b, p. 67-70), will be described in a later section and in table 5

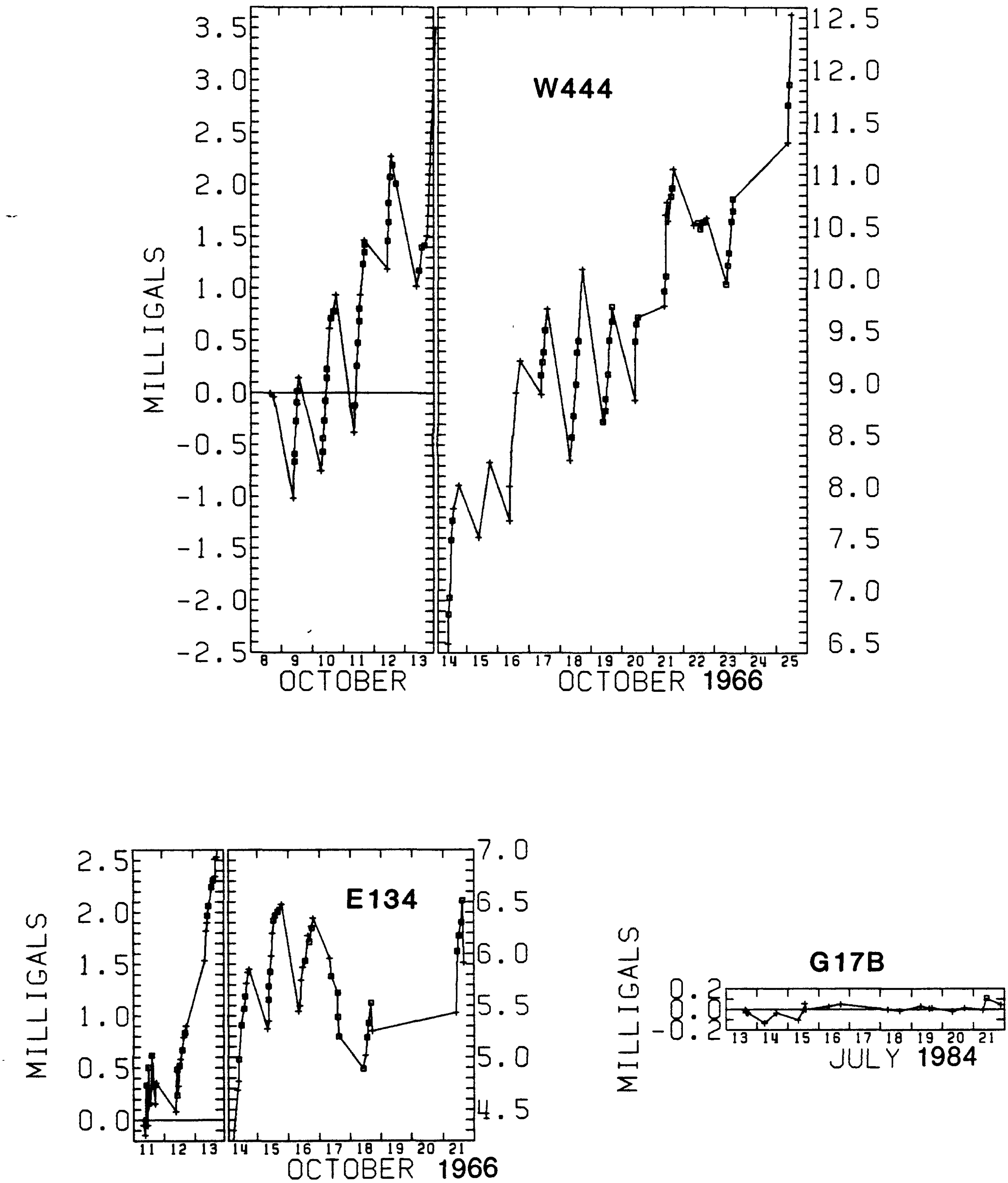


Figure 3.--Tide-corrected drift curves for gravity data collected in 1966 and 1984. Plus sign, base station. Square, selected station in 1966 and repeat station in 1984. Name, identification of gravity meter. Drift curves in 1966 encompass time in which 529 stations were established. Value of observed gravity was not found for 14 readings of base station "BELM " in 1966. Scales are the same as in Figure 5.

in Parts B and C.

The accuracy of observed gravity relative to base stations for about 1,700 gravity stations occupied with Worden gravity meters and reduced with the effect of Earth tides incorporated as part of the instrument drift correction was estimated by Healey and others (1980b, p. 2) as no better than 0.3 mGal. Tide-corrected drift curves prepared from recorded gravity readings illustrate the inherent error due to instrument drift (fig. 3). Values of observed gravity at some base stations originally occupied with Worden gravity meters were improved by later ties with LaCoste-Romberg gravity meters (table 1). Improvement of early drift curves by reoccupation of early gravity stations could not be achieved, because only nine reoccupations were made after the report by Healey and others (1980b). Gravity data from available field sheets also could not be re-reduced because instrument constants and values of observed gravity for some base and repeat stations, including stations located outside the quadrangle, are uncertain. The largest observed-gravity difference among the nine reoccupied stations is -0.75 mGal between base station "0250" (Healey and others, 1980b, p. 88) and station "RS03" (table 4 in Parts B and C), which was located on a bench mark. The negative sign of the difference indicates that the later value was higher. Other differences of observed gravity are 0.05, -0.1, -0.2, 0.2, -0.3, -0.3, -0.5, and -0.5 mGal.

After transferring previously published locations of the data points to 7 1/2-minute quadrangles, the geographic coordinates of 726 data points were changed by greater than 0.02 minute (denoted by the prefix "L" in revised station names). Elevations were changed by greater than 0.6 m (2 ft) for three data points (denoted by the prefix "E" in revised station names). Data points were discarded if uncertainties of their locations and consequent errors of elevations or terrain corrections were unacceptable. Spot checks of terrain corrections and contour plots of the difference between the original total terrain corrections and terrain corrections to station locations using the present digital terrain model revealed many large differences. Inasmuch as the original estimates for the inner terrain corrections using cylindrical-shaped sectors could not be found, the author estimated new inner terrain corrections for all data points and used the present digital terrain model for the outer terrain corrections. In view of the limited accuracy needed for contouring gravity anomalies at an interval of 5 mGal and a scale of 1:250,000, the work of hand terrain correction was minimized by consistently carrying hand terrain corrections to a distance of only 500 m. The average hand terrain correction for all data points was 0.18+/-0.48 mGal.

Data collected near Darrough Hot Springs Known Geothermal Resource Area

A total of 44 data points were accepted (table 3 in Parts B and C) from principal facts for 71 gravity stations established as part of the geothermal evaluation program of the U.S. Geological Survey (Peterson and Dansereau, 1976). Based on assumed repeat readings after 1980 at six gravity stations, 47.74+/-0.30 mGal was subtracted from the listed values of observed gravity, in order to adjust their datum to that of IGSN-71. An observed-gravity difference of 47.73 mGal was obtained at a bench mark, which was probably occupied by Peterson and Dansereau (1976) as a local base station, by comparison with the value of observed gravity at data point "L F 472" in the DMA data set (table 6 in Parts B and C). Unaccepted DMA data point " B177" from Mabey (1960) yielded a doubtful difference of 50.36 mGal at the bench mark. Most of the error by Peterson and Dansereau (1976) presumably resulted from an incorrect value of previously established observed gravity at the bench mark, with an unknown association to the cited year of 1975. The value of observed gravity at the datum of the U.S. National Gravity Base Net (USNGB) (Schwimmer and Rice, 1969) was correctly printed (ignoring a number 9 instead of a decimal point) for the primary base station occupied by Peterson and Dansereau (1976) at TONOPAH-J. Data for 35 stations listed on the first page of the report by Peterson and Dansereau (1976) are part of the DMA data set (source 4841), but a standard correction of 13.90 mGal was subtracted from USGS data, to account for the difference between the USNGB and IGSN-71 datums (Plouff, 1982, p. 3), consequently resulting in an error of about 33.8 mGal. Listing only the first 35 stations, Saltus and others (1981, table 5) applied a correction of 47.40 mGal.

Data collected for Nevada Cooperative and Conterminous U.S. Mineral Appraisal programs

Fieldwork and data processing were supervised by D.B. Snyder, Menlo Park, California, before 1984 (571 data points in table 4 in Parts B and C). Accuracies of values of observed gravity generally are better than previous gravity data collected by the U.S. Geological Survey because only LaCoste-Romberg gravity meters with low drift rates and well-established calibrations were used. But errors (fig. 4) as high as 10 mGal for the assumed value of observed gravity for base stations and a computer program error that led to the use of an incorrect calibration table for one gravity meter necessitated re-reduction of the gravity data by the present author. Errors of incorrectly transcribed observed-gravity values for base stations were eliminated by retaining only one value of observed gravity for base and repeat stations in one computer file and linking drift plots for entire field seasons (fig. 5).

Values of observed gravity were changed after the last principal-facts report by more than 0.05 mGal for 327 data points (denoted by the prefix "G" in the revised station name), including errors of 0.8 mGal or greater for 105 data points and errors greater than 9 mGal for 17 data points. A total of 15 sudden changes of reading level ("tares") occurred during the course of measurements (fig. 5). Most of the changes occurred as a result of loss of battery power and consequent decrease in instrument temperature.

Plots of station elevations on topographic maps, some of which were published after the gravity data were collected, showed significant discrepancies for previously reported data. For example, several surveyed elevations differed by about 30 m (100 ft) from contour estimates of the station elevations. Station elevations, however, could not be corrected because survey notes with location descriptions and elevation calculations were not found. Previously published data points with elevations that disagreed with contoured topography by greater than half a contour interval were not discarded. Compromises between locations along roads and elevations were made where previous hand-terrain correction forms indicated no discrepancies; accuracy estimates for horizontal locations and elevations, however, were raised. The geographic coordinates of 24 accepted data points were changed by greater than 0.02 minute (denoted by the prefix "L" in revised station names).

DATA COLLECTED BY A.H. COGBILL, JR.

Cogbill (1979) collected gravity data near the western edge of the quadrangle for a study of the crustal structure of an extensive region of western Nevada. Worden gravity meter 976, with a range of 200 mGal, was used to collect the gravity observations. The accuracies of base-station values of observed gravity was estimated at 0.3 to 0.4 mGal (Cogbill, 1979, p. 200). The gravity data were reduced in cooperation with the U.S. Geological Survey. A total of 22 data points (table 5 in Parts B and C) were accepted from 127 data points listed by Healey and others (1980b, p. 67-70). Many data points were rejected for the present report because they were established before topographic maps were available at scales of 1:24,000, and, consequently, locations and altimetrically-established elevations were doubtful, especially in contrast to nearby stations established later.

DATA FROM DEFENSE MAPPING AGENCY GRAVITY LIBRARY

A total of 1,039 data points were accepted from 5,768 data points in the DMA

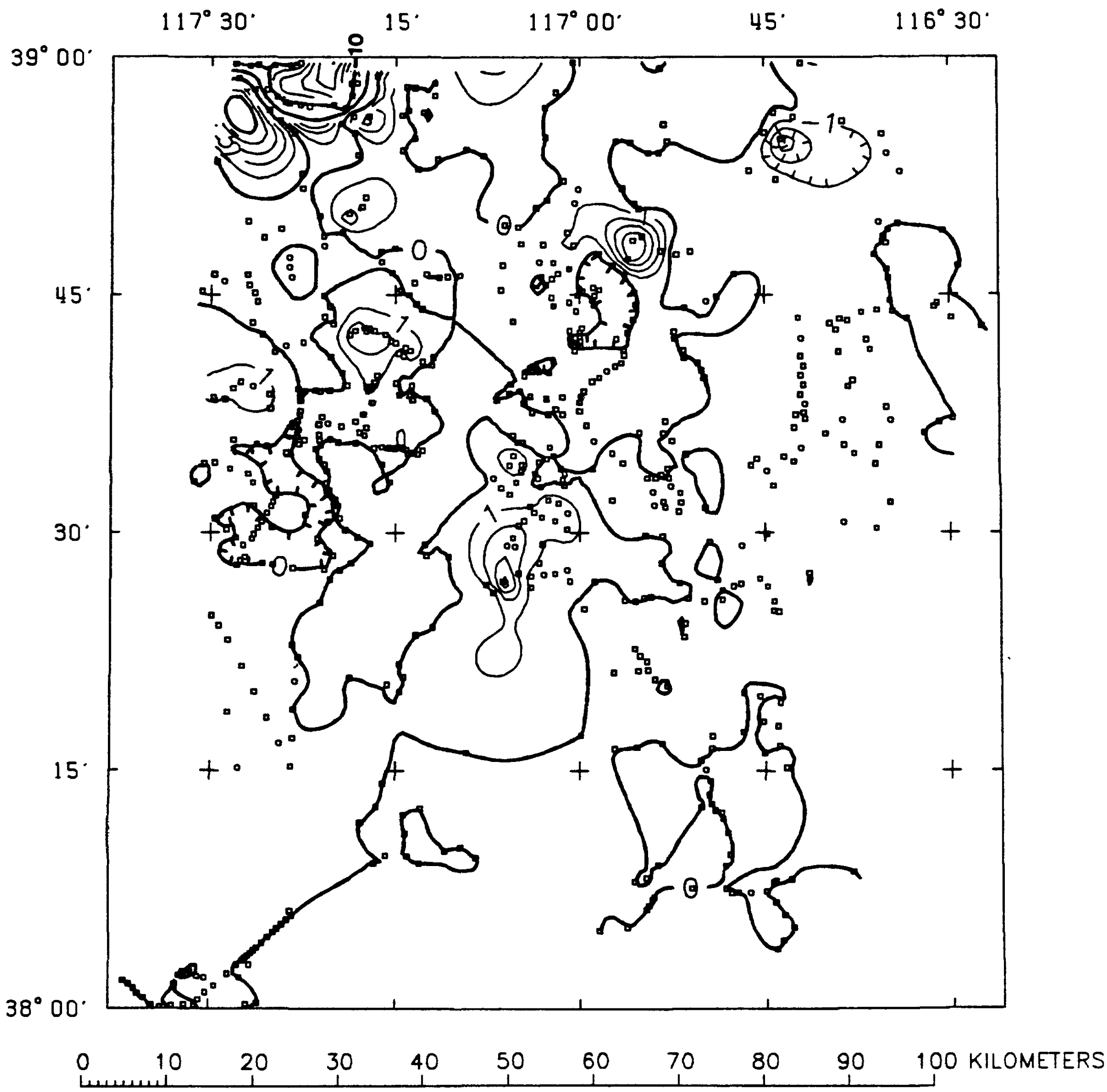


Figure 4.--Difference between present and previously published values of observed gravity for data collected between 1980 and 1983. Contour intervals, 1 and 5 mGal.

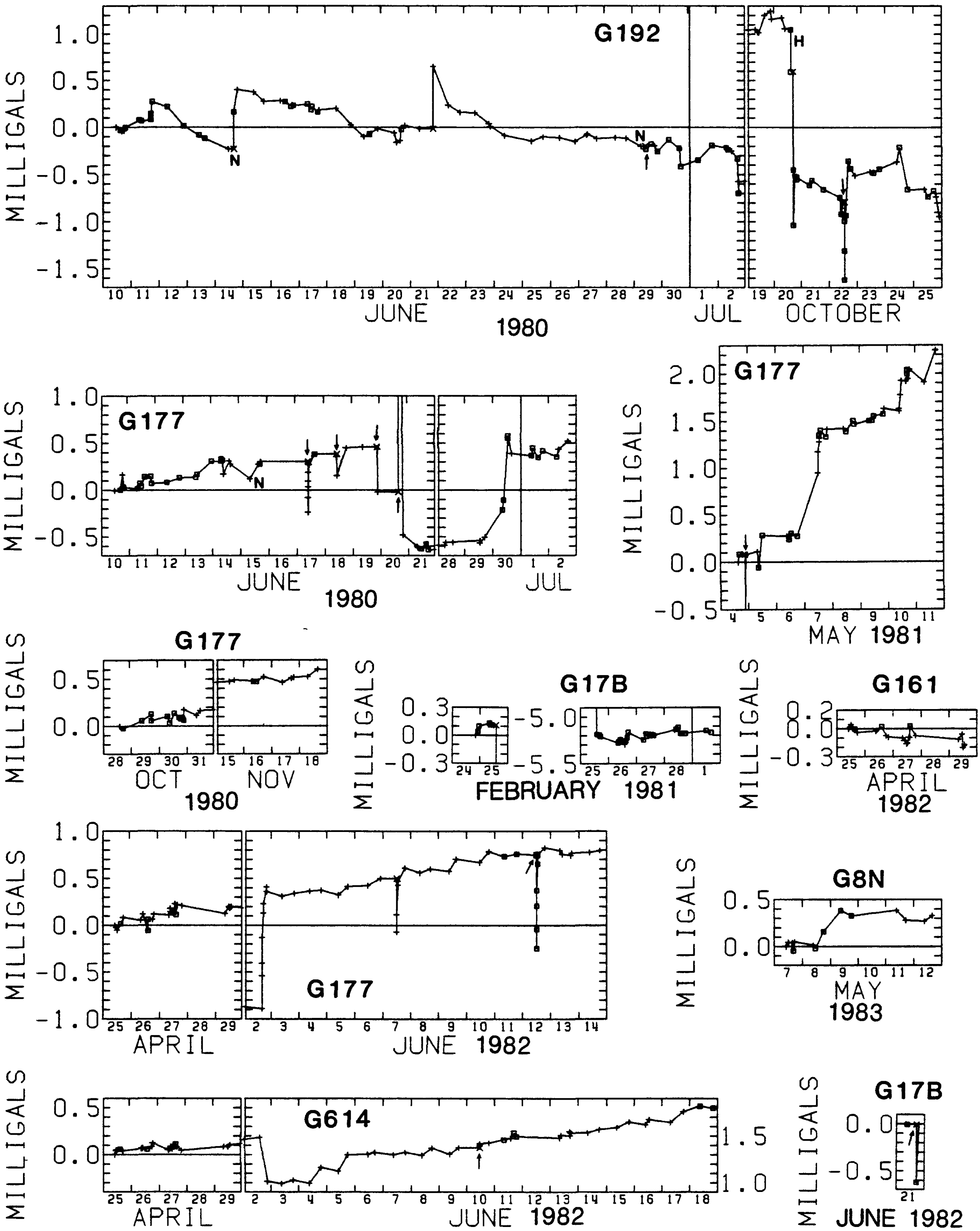


Figure 5.--Tide-corrected drift curves for gravity data collected between 1980 and 1983. +, base station. X, beginning of assumed tare. Square, repeat station. Name, identification of gravity meter. Arrow indicates time of instrument temperature change or battery power failure. H, instrument fell from pack horse and dial was reset. N, galvonometer needle motion.

data set (table 2) (table 6 in Parts B and C). Many of the excluded data points had doubtful locations or gravity anomalies, but most were redundant or are included in other data sets of this report. Data sets from two contributors to the DMA data set were excluded because their locations, elevations, and ties to presently established base stations are doubtful (number in parentheses indicates number of data points): 1) set 3503 (6) from "Woollard, 1939"; and 2) set 3502 (7), 3507 (3), and 3598 (4) from "University of Wisconsin" in the early 1950's.

Eight-digit station names initially consisted of a 4-digit source code followed by a 4-digit sequence number. For ease of associating data sources and reducing the number of characters for plotting, the source code was replaced by a single right-adjusted alphabetical character in the station name (table 2). The replacement 5-digit station name with a prefix of "TS" was listed in the position of the base station, to which the station was referred (digital columns 76-80 in table 6 of Part C) for stations from the DMA data set which were renamed by Healey and others (1980b, p. 70-75). Many data points in data source 5037 had the same sequence numbers. Therefore, unique station names were created by adding a letter before the sequence number. Letters added were "B" for stations near Big Smoky and Montezuma Valleys, "C" for Stone Cabin Valley, "H" for Hot Creek Valley, "R" for Ralston and Monitor Valleys, and "S" for Spring Valley. No prefix was added for stations in Railroad Valley.

After transferring originally published locations of the data points to 7 1/2-minute quadrangles, the geographic coordinates of 28 data points were changed by greater than 0.02 minute (denoted by the prefix "L" in revised station names). Station elevations were rounded to the nearest foot. Elevations were changed by greater than 0.6 (2 ft) for 5 data points (denoted by the prefix "E" in revised station names). Data points were discarded if uncertainties of their locations and consequent errors of elevations or terrain corrections were unacceptable. Many of the accepted data points were assigned low accuracy codes because their plotted locations were not near landmarks. One group of data points were regularly spaced, their elevations approximately agreed with topographic contour interpolation, and their gravity anomalies patterns were consistent with anomalies of neighboring stations, but many positions were, for example, near unmarked section corners. These data points were accepted because, according to information from the Defense Mapping Agency (oral commun., Werner Kosslowsky, 1987), inertial navigation or some other systematic positioning method may have been used.

Comparisons of values of observed gravity near sites occupied by the U.S. Geological Survey and common sites within the DMA data set suggested that consistency could be improved by adding constant values of observed gravity to selected data sources. Based on 39 direct ties and 12 indirect ties, about 0.1 mGal could be added to observed-gravity values in sources 4877, 5037, 5871, 5893, and 5907, but the scatter of the ties does not warrant a change. Based on 17 direct ties and 40 indirect ties, about 0.1 mGal could be subtracted from observed-gravity values in sources 5144, 5163, and 5171, but the scatter of the ties do not warrant a change. Based on 11 direct ties and 3 indirect ties, about 0.2 mGal could be added to observed-gravity values in sources 5116 and 5130, but the scatter of the ties do not warrant a change. A constant of 0.48 mGal should be added to the 2,297 values of observed gravity in source 2600, in order to agree with values of Healey and others (1980b) (table 2 in Parts B and C); the difference reflects an erroneous assumed value at the primary base station at the Tonopah Airport when the gravity data were incorporated into the DMA data set in 1977. Based on 33 direct ties yielding a difference of 1.13+/-0.39 mGal and 17 indirect uncorrected ties yielding a difference of 0.52 mGal, 1.00 mGal was subtracted from observed-gravity values in source 3047 ("J.W. Erwin, 1967, University of Nevada"). Based on 29 ties with a standard deviation of 0.23 mGal, 0.25 mGal was added to observed-gravity values in source 2179 ("U.S. Geological Survey, Nevada Basin and Range Project"); no publication of these values has been found.

Estimates for inner terrain corrections were carried to 500 m by the author for all data points in this set.

LISTS OF PRINCIPAL FACTS

Six tables and their associated diskette files contain principal facts for the gravity data. The information listed for each station fits in 80 columns for each digital record of the diskette files in Part C and is reformatted for readability of the tables in Part B. Although values of terrain corrections and anomalies are expressed to 0.01 mGal in the digital data, those values are printed only to the nearest 0.1 mGal, to reflect their accuracy.

Unique station names consist of 8 or less characters. Station names generally were retained in their original form, but prefices of L, E, or G were substituted in columns 1 to 3 of the station name if the location, elevation, or observed gravity, respectively, were significantly changed. Changes of location exceeded 0.02 minute of latitude or longitude, and changes of observed gravity exceeded 0.05 mGal before the prefices L or G, respectively, were inserted. There were 785 changes of location, 11 changes of elevation, and 385 changes of observed gravity. The letter "Q" was inserted into 10 station names where an elevation or location change was uncertain or the gravity anomaly was questionable but tentatively acceptable.

Values of observed gravity are referred to the IGSN-71 datum (Morelli, 1974). The free-air gravity anomaly uses the GRS-67 formula for normal gravity on the spheroid (International Association of Geodesy, 1971) and includes higher-order terms of Swick's (1942, p. 65) formula for the free-air correction.

A 4-digit code is used to specify the type of location (table 3) and the estimated accuracies of elevation (table 4), location (table 5), and, if available, the value of observed gravity (table 6) at each station. Elevation errors of 0.02 mGal/m, as applied to the Bouguer gravity anomaly, are the largest potential source of error. The accuracy of observed gravity depends on the type of gravity meter used, the magnitude of drift, and the number and quality of repeat readings. The accuracy of observed gravity for field data not reduced by the author is left blank in the principal-facts tables unless the type of gravity meter is known.

If available, dates or a range of years when the last gravity observation was made are included for each gravity station. The radius, to which the manual terrain correction was carried, is specified by a one-digit code. If available, the 5-digit name of the base station, to which the station was tied, is included. Therefore, if the value of observed gravity at a base station is improved, correcting the observed gravity at stations tied to that base is a simple computer process. Revised station names applied by Healey and others (1980b) to data obtained from the National Geophysical Data Center (1984) are included in the position of base station name (table 6 in Parts B and C), so that older data from other sources were identified and excluded from data collected by Healey and others (1980b) (table 3 in Parts B and C).

The following statistical information summarizes the principal facts for the 4,275 gravity stations. Elevations, which range from 1,374 to 3,640 m (4,508 to 11,941 ft) above sea level with an average elevation of 1,904+/-301 m (6,247+/-989 ft), where the last numbers indicates standard deviation. Values of observed gravity range from 979,071 to 979,615 mGal with an average of 979,443+/-57 mGal. Free-air gravity anomalies range from -67 to 139 mGal with an average of -2+/-30 mGal. Total terrain corrections range to 45 mGal with an average of 2.1+/-3.6 mGal. Complete Bouguer gravity anomalies range from -266 to -172 mGal with an average of -215+/-15 mGal. Values of isostatic residual gravity (fig. 1) range from -60 to 13 mGal with an average of -22+/-10 mGal. The standard deviation, which reflects scatter of data, is 5 mGal less for values of isostatic residual gravity compared to values of the Bouguer gravity anomaly.

ACKNOWLEDGMENTS

Don L. Healey was especially helpful in providing original field maps, copies of data sheets, computer printouts, and insight needed to evaluate early data collected by the U.S. Geological Survey . Allen H. Cogbill, Jr. provided information about gravity data that he collected here and in other parts of Nevada. Field assistants and party chiefs from the U.S. Geological Survey during this study included A.J. Bol, F.E. Currey, D.A. Dinter, R.N. Harris, D.L. Healey, P.E. Jansma, C.R. Karish, V.E. Langenheim, Donald Plouff, H.F. Ryan, R.W. Saltus, Lisa Senior, D.B. Snyder, and E.H. Softky.

REFERENCES

Bol, A.J., Snyder, D.B., Healey, D.L., and Saltus, R.W., 1983, Principal facts, accuracies, sources, and base station descriptions for 3672 gravity stations in the Lund and Tonopah 1-degree by 2-degree quadrangles, Nevada: National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22152, PB-83-202-671, 86 p.

Barnes, D.F., Oliver, H.W., and Robbins, S.L., 1969, Standardization of gravimeter calibrations in the Geological Survey: Eos (American Geophysical Union), v. 50, no. 10, p. 526-527.

Behrendt, J.C., and Woollard, G.P., 1961, An evaluation of the gravity control network in North America: Geophysics, v. 26, no. 1, p. 57-76.

Campbell, D.L., 1980, Gravity terrain corrections for stations on a uniform slope--A power law approximation: Geophysics, v. 45, no. 1, p. 109-112.

Cogbill, A.H., Jr., 1979, The relationship between seismicity and crustal structure in the western Great Basin: Evanston, Illinois, Northwestern University, Ph.D. thesis, 290 p.

Erwin, J.W., 1968, Gravity map of the Tonopah, Baxter Spring, Lone Mountain, and San Antonoio Ranch quadrangles, Nevada: Nevada Bureau of Mines and Geology Map 36, scale 1:125,000.

Godson, R.H., and Plouff, Donald, 1988, BOUGUER Version 1.0, A microcomputer gravity-terrain-correction program: U.S. Geological Survey Open-File Report 88-644; Part A, text of 13 p.; Part B, 5 1/4-inch diskette.

Hammer, Sigmund, 1939, Terrain corrections for gravimeter stations: Geophysics, v. 4, no. 3, p. 184-194.

Healey, D.L., Wahl, R.R., and Currey, F.E., 1980a, Complete Bouguer gravity map of the Nevada part of the Walker Lake 2-degree sheet: U.S. Geological Survey Open-File Report 80-519, 45 p., 1 sheet, scale 1:250,000.

-------1980b, Complete Bouguer gravity map of the Tonopah 1-degree by 2-degree quadrangle, Nevada: U.S. Geological Survey Open-File Report 80-611, 91 p., 1 sheet, scale 1:250,000.

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

Jablonski, H.M., 1974, World relative gravity network North America, Parts 1 and 2: Defense Mapping Agency Aerospace Center Reference Publication no. 25, originally published 1970, revised 1974 with supplement updating gravity values to the IGSN-71 datum, 1635 p.

Jachens, R.C., and Roberts, C.W., 1981, Documentation of the FORTRAN program, "isocomp", for computing isostatic residual gravity: U.S. Geological Survey Open-File Report 81-574, 26 p.

Mabey, D.R., 1960, Regional gravity survey of part of the Basin and Range province, IN Geological Survey Reserarch 1960: U.S. Geological Survey Professinonal Paper 400-B, p. B283-B285.

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

National Geophysical Data Center, 1984, DMA gravity file of the U.S.: National Oceanic and Atmospheric Administration, Boulder, Colorado, 2 magnetic tapes.

Oliver, H.W. (ed.), 1980, Interpretation of the gravity map of California and its continental margin: California Division of Mines and Geology Bulletin 205, 52 p.

Peterson, D.L., and Dansereau, Danny, 1976, Principal facts for gravity stations in the Darrough Known Geothermal Resource Area (KGRA), Nevada: U.S. Geological Survey Open-File Report 76-289, 3 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.

_____ 1982, Gravity observations in the Walker Lake 1-degree by 2-degree quadrangle, California-Nevada: U.S. Geological Survey Open-File Report 82-405, 105 p.

_____ 1987, Bouguer gravity anomaly and isostatic residual gravity maps of the Walker Lake 1-degree by 2-degree quadrangle, California and Nevada: U.S. Geological Survey Miscellaneous Field Studies Map MF-1382-E, 16 p., 2 sheets, scale 1:250,000.

Saltus, R.W., 1988, Gravity data for the state of Nevada on magnetic tape: U.S. Geological Survey Open-File Report 88-433, 20 p.; magnetic tape available from User Services Unit, EROS Data Center, Sioux Falls, SD

Saltus, R.W., Snyder, D.B., and Karish, C.R., 1981, Principal facts, accuracies, sources, base station descriptions, and plots for 1380 gravity stations in the Tonopah quadrangle, Nevada: National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22152, PB81-219-081, 88 p.

Schwimmer, P.M., and Rice, D.A., 1969, U.S. National Gravity Base Net: Eos, (American Geophysical Union Transactions), v. 50, no. 10, p. 527.

Swick, C.H., 1942, Pendulum gravity measurements and isostatic reductions: U.S. Coast and Geodetic Survey Special Publication no. 232, 82 p.

Woollard, G.P., 1958, Results for a gravity control network at airports in the United States: Geophysics, v. 23, no. 3, p. 520-535.

Table 1.--Base station descriptions

The following list provides the latitude, longitude, observed gravity in milligals, elevation in feet, and observer's descriptions of locations. The number in parentheses after the 5-digit base station name indicates the number of stations known to be tied to that base station. The following abbreviations are used: BM, level line bench mark; CGS, bench mark established by the U.S. Coast and Geodetic Survey (now the National Geodetic Survey); E, N, S, and W are compass directions east, north, south, and west, respectively; CL, centerline; Hwy, highway; and jct, crossing or intersection. "Secondary base" indicates that the station was repeated but the value of observed gravity is not as accurate as bases of the network, to which the auxiliary base station was tied.

0008 (510) 38D28.15' 116D 8.03' 6025 ft 979,460.45 mGal
23 mi NE of Warm Springs. 0.3 mi E of crest of Sandy Summit. About 300 ft N of Hwy 6. Just S of abandoned Hwy. On BM H-34 (Healey and others, 1980b, p. 86). "Sandy Summit" (or SANDY) of Bol and others (1983, p.34) has a value of 979,460.39 mGal. Secondary base.

0013 (194) 38D30.42' 116D18.43' 5537 ft 979,474.65 mGal
9.5 mi W of U.S. Hwy 6 and 2 mi E of the Hot Creek Ranch on the Hot Creek Ranch Road. 75 ft S of road. On ground next to BM K129 (Healey and others, 1980b, p. 87). Secondary base.

0050 (49) See" FISH"

0250 (15) 38D46.32' 116D47.47' 6917 ft 979,382.55 mGal
1.3 mi S of Pine Creek Ranch along Monitor Valley Road (Nevada Hwy 82). W of road. S of S end of fence line. On BM 13AAR (Healey and others, 1980b, p. 88). Secondary base. The gravity value is 0.7 mGal lower (table 4) at station "RS03" of Saltus and others (1981, p. 34), but their reading was taken less than 2 hours after the occurrence of a 5-mGal tare.

0365 (220) 38D41.95' 116D11.13' 6118 ft 979,459.2 mGal
Near survey point designated "H21." Plotted location near road jct (Healey and others, 1980b, p. 11). Secondary base.

0400 (28) 38D53.07' 116D 3.43' 6602 ft 979,459.2 mGal
Near survey point designated "F30." Plotted location on road, 0.2 mi E of main road (Healey and others, 1980b, p. 12). Secondary base.

0648 See "X-184"

2234 (27) 38D45.22' 116D 1.17' 6336 ft 979,458.19 mGal
No description found. Near USGS BM 107DOR. Value from Healey and others (1980b, p. 42). Secondary base.

3686 See "BLAIR"

3793 38D 7.68' 117D34.23' 4772 ft 979,516.7 mGal
About 20.5 mi E of Coaldale and 20 mi W of Tonopah along U.S. Hwys 6 and 95. About 50 ft S of Hwy CL. On BM K349 (Healey and others, 1980b, p. 89). Secondary base.

4159 (10) 38D24.56' 118D 6.08' 4579.8 ft 979,549.13 mGal
1.2 mi N along U.S. Hwy 95 from Mina, Nev. and thence 0.9 mi E along gravel road to dump. On CGS BM A360 (station HMINA of Plouff, 1982, p.32). Healey and others, 1980a, p.43) used value of 979,549.02 mGal.

4415 (112) 38D49.20' 117D59.07' 4579 ft 979,595.63 mGal
About 4.6 mi SSW along Nevada Hwy 23 from the post office in Gabbs. Then,

about 1.1 mi WNW along dirt road to Rawhide. 22 ft S of road CL. Ground next to CGS BM N295 (Healey and others, 1980b, p. 90). Secondary base.

13365 (60) Either base station 0013 or 0365.

5MILE (14) 38D18.58′ 116D16.52′ 5218 ft 979,439.9 mGal
1 ft N of "JCT AHEAD" sign on road to Tybo. About 500 ft N of U.S. Hwy 6. Not described by Healey and others (1980b). Independently derived value agrees with original notes (D.L. Healey, written commun., 1987). Secondary base.

80013 (5) Either base station 0008 or 0013.

80365 (2) Either base station 0008 or 0365.

AUSTN (22) 39D29.41′ 117D 4.02′ 6640 ft 979,514.90 mGal
At Federal Office Building on E side of Austin, Nevada. Corner of Main St. and 7th St. Top stair of porch at N (main) door. 1 ft W of door. On disc marking ACIC-2353-1 (Jablonski, 1974).

BARL 38D39.23′ 116D38.22′ 7245 ft 979,384.21 mGal
At 3-way jct 0.5 mi E of Barley Creek Ranch. 0.1 mi W of ford. 10 ft W and 12 ft N of jct CL (Saltus and others, 1981, p. 12). Gravity value is 0.33 mGal lower than previously reported. Secondary base.

BASEA (47) 38D 1.9′ 116D10.2′ 6430 ft 979,417.7 mGal
No description was found. Near road jct at site of Reveille, Nev. Value is tied to base station X-184 (D.L. Healey, written commun., 1987). Secondary base.

BELC (59) 38D35.76′ 116D52.51′ 7385 ft 979,375.36 mGal
On ground just SW of S corner of abandoned courthouse in Belmont (Bol and others, 1983, p.17). Contour estimate for elevation. Also "Belmont C".

BELM (108) 38D35.74′ 116D52.45′ 7427 ft Value not found
Assumed location near BM M128 (not shown on 1971 topographic map). Described as near disturbed BM M128. BM was described as 600 ft E of (abandoned) courthouse at Belmont, Nev. 57 ft NE of jct of Second and Main Streets. Loops to other stations of base network shown by D.L. Healey (written commun., 1987) indicate values of 979,374.0, 979,374.3, 979,374.4, 979,374.4, and 979,374.85 mGal. Re-reduction of field data indicates a value of 979,374.7+/-0.25 mGal for 6 readings tied to other base stations.

B5602 (44) 38D49.26′ 117D10.89′ 5603 ft 979,495.7 mGal
Probably near USGS BM "5609, 1907" near Darrough Hot Springs. Typographical error apparently led to reported computer gravity value that is about 47.7 mGal too high for this station and for associated Darrough Hot Springs stations (Peterson and Dansereau, 1976, p. 2). Gravity values reported by the National Geophysical Data Center (1984, source 4841) correspondingly are 33.8 mGal too high. Gravity value established indirectly by ties to 5 stations of this survey with a standard deviation of 0.3 mGal. Secondary base.

BLAIR 38D 0.58′ 117D46.67′ 4819 ft 979,497.68 mGal
0.7 mi S of Blair Junction on Nevada Hwy 265; then 0.4 mi W on old railroad grade. On BM triangulation station Blair (Bol and others, 1983, p. 18). Also "3686" (Healey and others, 1980b, p. 89). Secondary base.

CLOV (34) 38D36.31′ 117D31.68′ 6127 ft 979,472.46 mGal
3.7 mi N of Cloverdale Ranch. 50 ft W of abandoned prospect. 38 ft E of road CL. On BM JRH14 in tuff outcrop (Bol and others, 1983, p. 21).

FISH 38D43.00′ 116D27.40′ 6577 ft 979,421.42 mGal
0.2 mi W of Fish Lake Valley Ranch. In triangle of jct of Fish Lake Valley

and Danville Canyon Roads. On ground near small wooden hub later replaced by BM 53-0 (Bol and others, 1983, p. 24). Value reported at "0050" of Healey and others (1980b, p. 87) was 979,421.5 mGal. Secondary base.

FISHL 38D31.82′ 116D28.98′ 6200 ft 979,439.8 mGal
No description of secondary base found. Near southwestmost jct of roads N into Little Fish Lake Valley and E into Hot Creek Canyon. Accuracy not better than 0.3 mGal.

HUNT (38) 38D26.60′ 116D47.57′ 7040 ft 979,371.23 mGal
At Hunts Canyon Ranger Station (end of road into Hunts Canyon). On concrete stoop in front of cabin door (Bol and others, 1983, p. 26).

JOHN 38D44.45′ 116D30.98′ 7380 ft 979,388.18 mGal
In doorway of Wagon Johnnie abandoned ranch in Green Monster Canyon. Secondary base.

LONE (38) 38D 8.44′ 117D27.36′ 4816 ft 979,518.59 mGal
118 ft S and 41 ft W of gravel road jct 13.7 mi W of Tonopah along U.S. Hwy 6. 7 ft W of fence corner. On concrete post, CGS BM G349 (Bol and others, 1983, p. 27).

MEAD (28) 38D41.63′ 116D55.13′ 8030 ft 979,338.87 mGal
On red spot on front step of Meadow Canyon Guard Station (field notes by E. Softky, 1982). Secondary base tied to BELC.

MRC1 38D53.60′ 117D11.59′ 5475 ft 979,495.43 mGal
Jct of Nevada Hwy 376 and road along Monitor Valley via Moores Creek Road. In SE vee. 2 ft E of hwy road pole (Saltus and others, 1981, p. 20). Secondary base.

PEA (213) 38D37.01′ 117D18.13′ 6270 ft 979,457.70 mGal
Peavine National Forest Campground. On 3X5X3-ft rock N of W end of driveway to E of and in line with outhouse (Bol and others, 1983, p. 29).

PEAV 38D31.91′ 117D11.87′ 5853 ft 979,480.9 mGal
Near jct of Nevada Hwy 8A and road along Peavine Canyon, about 17 mi S of Round Mountain (Healey and others, 1980b, p. 90). Gravity value (estimated to accuracy of 0.3 mGal) differs from published value of 979,444.1 mGal. Doubtful secondary base.

REES 38D47.39′ 117D23.36′ 7805 ft 979,373.91 mGal
3 mi E along pack trail into Reese River Valley from trailhead at Cow Canyon. On stone step at E corner of the stone cabin for U.S. Forest Service administration (Bol and others, 1983, p. 32). Secondary base.

REST 38D 7.8′ 116D46.0′ 5900 ft 979,458.02 mGal
At rest stop about 20 mi E of Tonopah along U.S. Hwy 6. Just SW of NE corner of fenced area E of road along Saulsbury Wash (Saltus and others, 1981, p. 24). Secondary base.

ROUND (30) 38D42.68′ 117D 4.08′ 6360 ft 979,455.66 mGal
In town of Round Mountain. SW of and opposite side of street from Telephone Company building. On concrete porch 1 ft SE of N corner and 0.25 ft NE of the NE wall of the former Post Office (now a private residence). On a disc marking station ACIC-2359-1 (Jablonski, 1974). Also "ROUND MT B" and "IGB 12087B". Gravity value adjusted 0.03 mGal higher than that of Jablonski (1974), to agree with ties to accepted value at TONOJ.

TONO (231) 38D 3.50′ 117D 5.22′ 5426 ft 979,462.52 mGal
At Nye County Airport, 8 mi E of Tonopah. At barrier, at gate opposite terminal lobby entrance (Woollard, 1958, p. 533). Gravity value was determined

by 4 close ties to TONOJ in 1973. Coarser value of 979,462.5 mGal (Healey and others, 1980, p. 85), consistent with the accuracy of Worden gravity meter readings, apparently was obtained by subtracting a commonly applied constant of 13.9 mGal from Woollard's (1958) value in order to convert data collected by the U.S. Geological Survey in central Nevada from the Woollard datum to the IGSN-71 datum. However, Behrendt and Woollard (1961, p. 74) published a value 0.3 mGal higher than that of Woollard (1958). Also "WA40" and "0455-0".

TONOJ (206) 38D 3.70' 117D 5.95' 5413 ft 979,462.25 mGal
At Nye County Airport, 8 mi E of Tonopah. SW of a six-way jct of a taxiway, Midway St., and B St. 0.4 mi SW of FAA office. 30 ft SW of CL of Midway St. 3 ft W of a telephone pole. On ground next to partly destroyed BM B-297 post. Site of ACIC-0455-1 or (Jablonski, 1974). Was primary base station in quadrangle. Value of observed gravity may be 0.05 mGal lower (written commun., Defense Mapping Agency Geodetic Survey Squadron, 1987). Also "Tonopah J", "0455-1", or "IGB 12087J".

TONOK 38D 3.83' 117D 5.73' 5397 ft 979,462.58 mGal
At Nye County Airport, 8 mi E of Tonopah. Inside the FAA building, adjacent to the runway and parking area. On floor near center of the N wall of the main office (Saltus and others, 1981, p. 27). Mark covered by carpet in 1984. Gravity value is 0.33 mGal higher than TONOJ (written commun., Defense Mapping Agency Geodetic Survey Squadron, 1987). Also "IGB 12087K" or "FAA".

TONSN (70) 38D 4.64' 117D14.80' 5860 ft 979,454.72 mGal
Near NW edge of Tonopah. 1 ft SW of SE corner of 4X13-ft concrete slab at base of steps in SW corner of 3-story building of Sundowner Motel. Auxiliary base station tied to TONOK in 1984.

TYBO 38D22.89' 116D32.29' 6332 ft 979,420.9 mGal
CL between legs of signpost at jct of Tybo and Fish Lake Valley Roads. Occupied but not reported by Healey and others (1980b). Secondary base.
GOOD TO? NEED?

WARM (123) 38D11.00' 116D22.15' 5419 ft 979,482.85 mGal
0.2 mi S of Warm Springs, on old route of Nevada Hwy 4. About 720 ft E of large hot spring. 42 ft E of CL of old Hwy. W of U.S. Hwys 6 and 95. At base of disturbed BM X-34 (Healey and others, 1980b, p. 86). Gravity value may be 0.5 mGal lower than this reported value. D.L. Healey (oral commun., 1990) reported that there was a discrepancy in observed value obtained from a regional network in northern Nevada at this station. Secondary base.

X-184 (175) 38D 8.98' 116D 6.24' 5026 ft 979,511.80 mGal
15.5 mi E along Nevada Hwy 25 from the jct with U.S. Hwy 6 at Warm Springs. Then, 0.1 mi NE along dirt road to Currant. 20 ft N of road. At SE corner of stock loading pen. On BM X-184 (Healey and others, 1980b, p. 91). Also station " 0648" but value reported as 979,511.73 mGal (Healey and others, 1980, p. 16). Secondary base.

Table 2.--Sources of data from Defense Mapping Agency Gravity Library.

[Data are listed in table 6 in Parts B and C. Prefix, letter in column 3 or 4 of station name, which indicates source of data. Code, 4-digit code associated with source of gravity data. Number, number of data points available and accepted from the source (two columns). DG, value of observed gravity added (in milligals), in order to adjust datum to that of other observations in this report. DMA, Defense Mapping Agency, Topographic Command or Geodetic Survey Squadron at Cheyenne, Wyo.]

Prefix	Code	Number		DG	Agency, description
A	3915	33	4		DMA, Nevada regional gravity survey, 1973
B	2179	102	2	0.25	U.S. Geological Survey Basin and Range (Mabey, 1960)
E	3047	120	11	-1.00	University of Nevada, Tonopah area, 1967 (Erwin, 1968)
F	5116	80	20		DMA, Nevada, 1968
H	5144	48	14		DMA, Nevada, 1971
M	5871	53	347		DMA, Little Smokey and Antelope Valleys, 1981
	5893	325			Penoyer, Coal, Garden, and Reveille Valleys, 1981
	5907	165			Monitor and Grants Range Valleys, 1981
N	5037	559	296		DMA, Arizona and Nevada, 1979
Q	5130	19	2		DMA, Nevada, 1969
U	4877	369	284		DMA, Ralston Valley
X	5163	180	59		DMA, Nevada, 1972
	5171	21			Nevada, 1972

Table 3.--Location description code (digit one)

[Number indicates the total number of gravity stations for which code was used.]

Code	Number	Explanation
B	2	On level-line bench mark or other permanent mark incorporated into U.S. Geological Survey vertical control system, including National Geodetic Survey bench marks.
N	410	Near level-line bench mark of U.S. Geological Survey system. Many of these stations occupied between 1980 and 1982 may be on bench marks but field notes were not taken.
V	1	On vertical-angle bench mark in U.S. Geological Survey control system.
H	41	Near or possibly on vertical-angle bench mark.
D	2	Near assumed location of any of the above marks that was destroyed or not found.
P	799	Near surveyed elevation with or without a permanent mark.
F	84	Near location with or without a mark, at which a surveyed elevation is shown on a published topographic map.
G	1880	Near location (on a manuscript or published map) at which a spot elevation is determined by photogrammetry; near doubtful F-location.

T	352	Elevation based on photogrammetry done by by U.S. Geological Survey; or spot elevation not printed on published topographic map.
A	2	Elevation determined by using altimetry with unknown accuracy.
Q	4	Elevation determined by interpolation of topographic contours that intersect intermittent drainage, stream, or river channel.
C	8	Elevation determined by topographic contour interpolation at less precise location than defined by "Q".
2	207	Location along fairly regularly spaced profile of stations; elevation source is unknown.
3	193	Location near road or section line; elevation source is unknown.
U	290	Location not near road or other landmark; elevation source is unknown.

Table 4.--Accuracy of elevation code (digit two)

[Number indicates total number of stations for which code was used. The error of the Bouguer gravity anomaly is 0.02 mGal/m. Uncertainty of horizontal location tends to degrade elevation accuracy.]

Code	Number	Accuracy (m)	Bouguer anomaly (mGal)	Examples
1	2	0.05	0.01	On or tied to level-line bench mark by surveying.
2	159	0.15	0.03	Elevation difference hand-leveled to nearby bench mark; elevation only recorded to nearest foot.
3	253	0.3	0.06	Near bench mark.
4	26	0.6	0.12	On or near vertical-angle bench mark; flat area near level-line bench mark that was not found.
5	512	1.5	0.3	Near surveyed spot elevation on topographic map; elevation from map with 10-ft contour interval
6	1731	3.0	0.6	Photogrammetric elevation or contour interpolation on map with 20-ft contour interval.
7	1331	6.0	1.2	Uncertain location of photogrammetric spot elevation.
8	260	15.0	3.0	Contour interpolation along road or stream on map with 80-ft contour interval; doubtful combination of elevation and horizontal location.
9	1	30.0	6.0	Place where original elevation was that of a spot elevation on a different hillcrest.

Table 5.--Accuracy of horizontal location code (digit 3)

[Number indicates total number of stations for which code was used. Error of Bouguer gravity anomaly is based on assumption that all location error is along the north component of direction.]

Code	Number	Accuracy (m)	Bouguer anomaly (mGal)	Examples
1	1	13	0.01	Near vertical-angle bench mark. No information was available to show how close to the mapped location were 41 stations with location code "H".
2	251	25	0.02	Near permanent mark on map such as bench mark, section corner, or well.
3	753	65	0.05	Road intersection or stream fork.
4	1273	130	0.1	Broad road curve or gentle hillcrest.
5	1339	250	0.2	Location depends on odometer measurement over interval greater than 1 mi, or other estimate. Map location of surveyed station that differs by up to 840 ft from previously published location.
6	679	650	0.5	Location approximately agrees with elevation but is located 0.5 mi from a likely landmark.
7	18	1,300	1.0	No likely landmark within 1 mi.
8	3	2,500	2.0	Original location changed by 1 to 2 mi, to agree with location of the given elevation.
9	2	over 2,500	5.0	Original location was another hillcrest incorrectly assigned elevation of this hillcrest.

Table 6.--Accuracy of observed gravity code (digit four)

[Number indicates total number of stations for which the code was used. Accuracy primarily reflects accuracy of tie to base station, to which station was tied, and secondarily depends on accuracy of observed gravity at the base station.]

Code	Number	Accuracy (mGal)	Examples
1	1	0.01	Code used to identify base station established with LaCoste and Romberg gravity meter.
2	0	0.02	Station established with multiple ties of high precision.
3	15	0.05	Repeated readings with LaCoste and Romberg gravity meter.
4	469	0.1	One reading with LaCoste and Romberg gravity meter.
5	131	0.2	Single tide-corrected reading with Worden gravity meter with good drift characteristics.
6	45	0.5	Near time of apparent tare of 0.5 mGal. Reading is average of two readings that are 1.0 mGal apart.
G	520	0.15	LaCoste and Romberg gravity meter with tide correction.
L	249	0.2	LaCoste and Romberg gravity meter, probably without tide correction.
M	48	0.25	Worden gravity meter with excellent drift characteristics but unknown reduction procedures.
E	1394	0.35	Worden gravity meter with good drift characteristics but no tide correction.
W	262	0.5	Worden gravity meter with unknown or poor drift characteristics and unknown reduction procedures.
None	1097		Accuracy unknown. See text for estimated observed-gravity accuracy for specific sets of data.