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

# PRINCIPAL FACTS AND FIELD OBSERVATIONS FOR GRAVITY DATA IN AND ADJACENT TO THE BUREAU OF LAND MANAGEMENT'S WINNEMUCCA DISTRICT AND SURPRISE RESOURCE AREA, NORTHWEST NEVADA AND NORTHEAST CALIFORNIA

*By*

**Donald Plouff[1]**

96-290-A Documentation (paper copy)
96-290-B Digital gravity data (3½-inch IBM-compatible diskette)

**Open-File Report 96-290-A**



**1996**

---

[1]Menlo Park, California 94025

# CONTENTS



# ILLUSTRATIONS



# TABLES

## INTRODUCTION

The gravity data covers the Bureau of Land Management's Winnemucca District and Surprise Resource Assessment Area (WSRAA) (fig. 1) and a band that extends outward as far as 30 km (20 mi) as part of the geophysical element of a geologic assessment for mineral, oil and gas, and geothermal resources. This report releases in digital format a compilation ("principal facts") for 7,075 data points (fig. 2), records of field observations, and other selected data and boundaries. Inasmuch as locations, elevations, values of observed gravity, terrain corrections, and gravity anomalies for previously established data have been changed and previous data points have been deleted by the author, it is necessary to include the following detailed explanation of the steps needed to obtain the final data set. Data sets from specific sources are discussed individually and with respect to specific one- by two-degree quadrangles. Further work needed to improve the quality of the data also is discussed.

The diskette for Part B includes a **"README."** file that explains the format and contents of the diskette (table 1). The 3 ½-inch personal computer (PC) diskette (double-sided, high-density) contains files of principal facts and files of field observations for data in this report. The terms "data point" and "station" will be used interchangeably in this report. Records in files with "principal facts" (file names with a suffix of **.ISN**) include unique station names, geographic coordinates, elevations, values of observed gravity, accuracy codes, free air gravity anomalies, dates of last observation (or simple Bouguer gravity anomaly), inner terrain corrections, total terrain corrections, outer radii of inner terrain corrections (or code for computer terrain correction all the way to the data point), Bouguer gravity anomalies, values of isostatic residual gravity, and base station names or other information. Records for data points evaluated as erroneous or redundant (file names with a prefix of **DELETE**) have the same format as principal facts but usually include explanations at ends of records. Files of principal facts are arranged in directories (folders) for Oregon and for eight one- by two-degree quadrangles. Within directories, files are further subdivided by data sources. Files with field observations (file names with a suffix of **.FLD**) include station names, dates, times, readings, elevations, accuracy codes, innermost terrain corrections, and map designations. Files that specify vertices of polygons used to extract data are included. Directory and file names are indicated by uppercase or bold print in the following discussion.

### Acknowledgments

Ronald R. Wahl of the U.S. Geological Survey provided copies of data sheets and useful information for the Carson Sink gravity survey. Donald H. Schaefer of the U.S. Geological Survey provided data in digital format and useful information about gravity data collected for hydrologic investigations of valleys.. Allen H. Cogbill, Jr. of the Los Alamos National Laboratory provided detailed unpublished station descriptions for his extensive gravity survey. Prof. John W. Erwin of the University of Nevada at Reno coordinated a cooperative program and provided data and information for the Reno quadrangle. Robert F. Sikora of the U.S. Geological Survey provided information about gravity data in the Winnemucca quadrangle. David A. Ponce of the U.S. Geological Survey provided information about gravity data along the PASSCAL seismic line and in the McDermitt quadrangle. Donald L. Peterson of the U.S. Geological Survey provided information about gravity surveys of the Baltazor and Pinto Hot Springs areas. Volunteers Rex V. Allen and Edwin Nelson admirably assisted the fieldwork in 1993.

## COMPILATION METHODS

Steps to improve quality during the compilation of existing gravity data were to delete duplicate data, to correct or delete erroneous data, and to evaluate the accuracy of accepted data. Duplicate data could not be easily identified when previous compilers modified values of observed gravity, modified locations, or copied earlier data into their sets and then substituted different station names. The pattern of two sets of sequence numbers at associated data points often could be recognized except in cases where a later compiler modified locations or sorted data points by their latitude and then replaced original station numbers with numerical sequence numbers. Unless a less accurate data point is closely surrounded by data points of a less accurate data set or the data set with generally higher accuracy apparently copied the less accurate data point, the less accurate data point was discarded.

Data points with the same station names as other data points or without a station name, which occurred in subsets of data from the National Geophysical Data Center (table 2), were assigned unique station names. Data points located near spot elevations or bench marks, near cultural features such as roads or marked section corners, or arranged along regularly-spaced lines or grids generally were accepted with minor modifications. The last method for identifying data points to be rejected, corrected, or accepted was to look for conspicuous disagreements (forming one-station "bullseye"

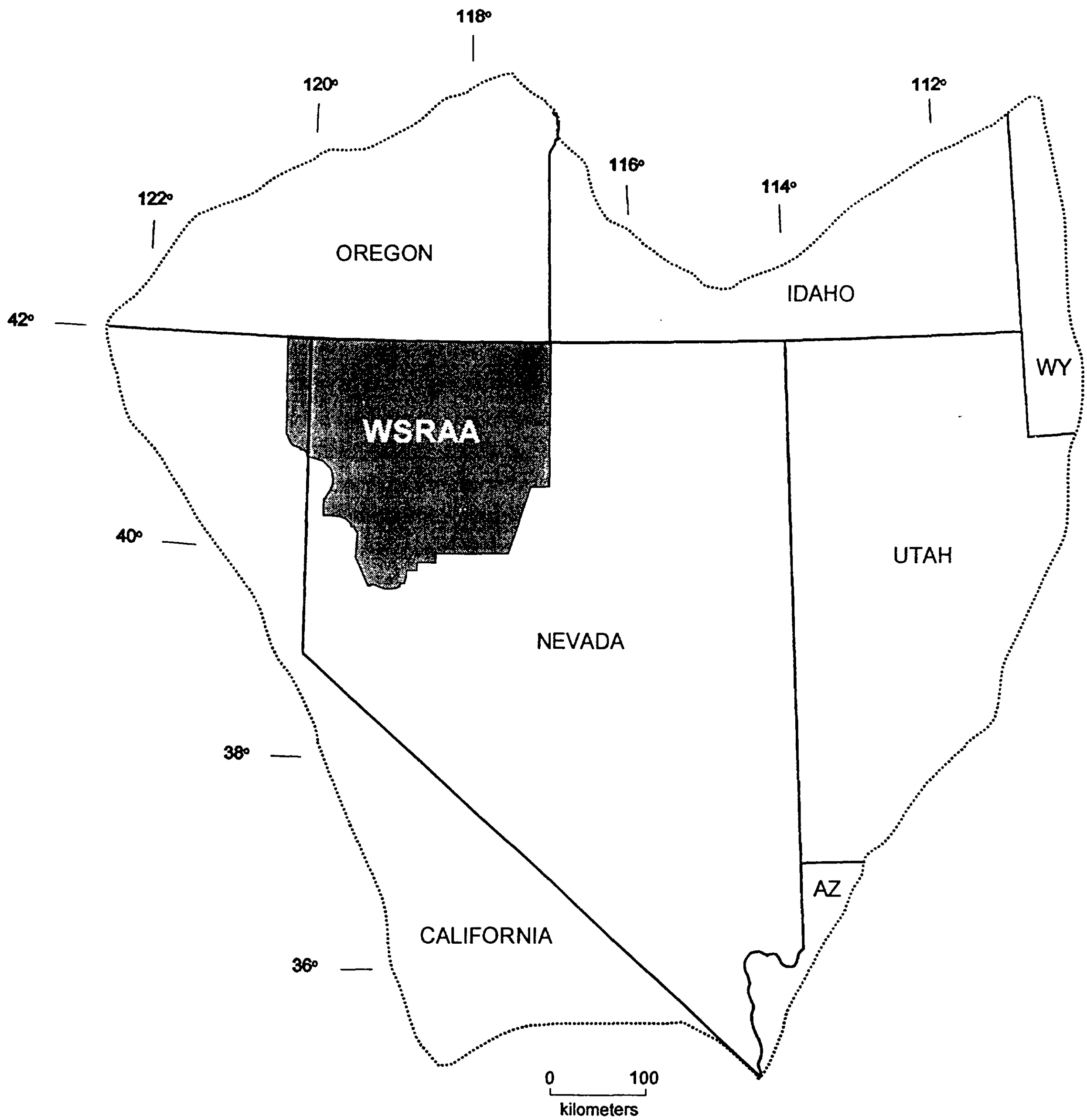


Figure 1.--Index map of Great Basin showing location of Winnemucca-Surprise Resource Assessment Area (WSRAA).

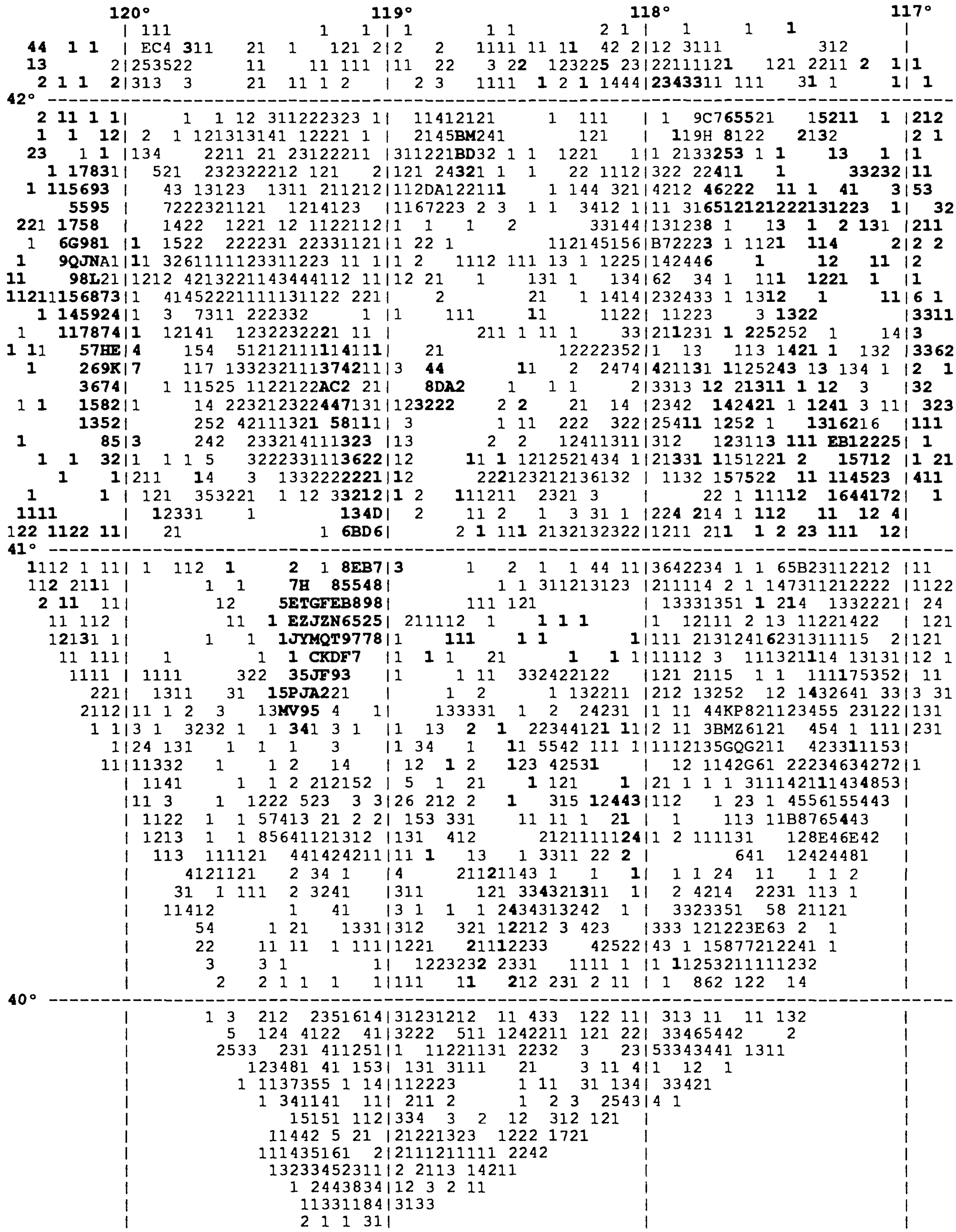


Figure 2.--Index map showing distribution of gravity data in study area. Numbers and letters indicate number of data points in 2.5-minute cells that include their south and east edges. Blank spaces indicate no data. For example, A indicates 10 data points, I and O are skipped, Y indicates 31 data points, and Z indicates 32 or more data points. **Bold print** indicates location that includes data points without map verification. North-south distances are exaggerated about 1.3 times east-west distances.

shapes on contour plots of gravity anomalies) between the terrain-corrected Bouguer gravity anomaly of the data point and anomalies at adjacent points. Coded location descriptions (table 3) were obtained from original data sources or from map plots during the present study. Elevation accuracy codes and location accuracy codes (table 3) were included for some data points. The accuracy of observed gravity (table 3) was estimated for most data collected by the U.S. Geological Survey. In addition to the presence of elements of the accuracy code, modifications of station (data point) names indicate that corrections of locations or elevations were made.

## OBSERVED GRAVITY

The datum of observed gravity for data points listed in this report is the International Gravity Standardization Net of 1971 (IGSN-71) described by Morelli (1974). To achieve consistency of observed gravity among data sets, constant datum shifts to values of observed gravity were applied to data sets, if observations apparently at the same locations in other established data sets indicated consistent differences of observed gravity. The need for a datum shift for a set of data primarily results from the lack of a tie to a common base station and secondarily results from imprecise gravity meter calibration. Datum shifts were determined empirically, inasmuch as observer's notes and records of field readings were not obtained. For data sets that encompass large areas, datum shifts in this report were determined separately for each one- by two-degree quadrangle. Gravity changes associated with changes such as subsidence, shifts of water table, or earthquake fracturing during intervals between repeated measurements are assumed to be small compared to 0.1 mGal typically expected for the best accuracy of gravity anomalies.

## LOCATIONS

A substantial part of the gravity data was collected before 7 ½-minute topographic maps were available to provide location control. Only one- by two-degree topographic maps were available to some observers at the time of their gravity surveys. To the extent practical, station names and elevations were computer-plotted on available 15-minute and 7 ½-minute topographic maps so that locations of existing data could be corrected. Data points were discarded if uncertain locations and consequent errors of elevations or terrain corrections could not be easily reconciled by modifying their locations or elevations. Data points with locations that markedly disagreed with topography or culture and data points too closely spaced for uncertainties of their locations or consequent uncertainties of terrain corrections were discarded or were selectively retained, one of three closely spaced points, for example.

## ELEVATIONS

Elevation errors generally are the largest source of error in calculating Bouguer gravity anomalies. An elevation error of 0.3 m generates an error of 0.06 mGal for the Bouguer gravity anomaly. Elevation errors attributed to inaccuracies as large as 3 m (corresponding to 0.6 mGal for the Bouguer gravity anomaly), for example, is associated with some photogrammetric or altimetric elevations but is acceptable when applied to the present application of interpreting regional gravity maps with contour intervals of 5 mGal. An error of 0.6 mGal, however, would be unacceptable if gravity stations are closely spaced and local anomalies are to be interpreted. The greatest limitation to efficiency and consequent productivity in obtaining regional gravity data coverage is the limited availablity on topographic maps of photogrammetrically determined spot elevations along numerous roads without benchmarks, in contrast to ubiqitous spot elevations on less accessible hilltops. Hilltops locations also are less desirable because the effects of terrain correction and variable rock density distribution--for an extreme example, cinder cones--are difficult to analyze.

## TERRAIN CORRECTIONS

Gravity terrain corrections are the gravity effect of departures of the Earth's surface from a horizontal plane that passes through the station when calculated near the gravity station or departures from a spherical cap at farther distances, for example, beyond 8,440 m (Swick, 1942, p. 68). Topographic information needed to calculate the innermost part of of a terrain correction, the part of topography not resolvable at the scale of topographic maps, must be obtained in the field. Terrain corrections are estimated in the field to distances of 53 or 68 m by the U.S. Geological Survey. The remaining part of the inner terrain correction was estimated, to the extent practical, in previous studies by the U.S. Geological Survey to distances of about 400 to 900 m (1,300 to 3,000 ft) by evaluating elevations and slopes within compartments bounded by radial lines and circles on transparent templates (for example, Hammer, 1939; Swick, 1942; Campbell, 1980).

Terrain corrections that include the effect of the Earth's curvature were determined in the remaining distance to 166.7 km (103.6 mi) by using a computer program that incorporates a model of average elevations digitized at intervals of 15 seconds, 1 minute, and 3 minutes (Plouff, 1977c; Godson and Plouff, 1988). The terrain model (modified from a model available from the National Geophysical Data Center in Boulder, Colorado) was derived from digitization of topographic maps at scales of 1:250,000. The accuracy of the digital model was evaluated by contouring the difference between station elevations and linearly interpolated elevations of the terrain model (program STAELERR from Godson and Plouff, 1988). Elevation disagreements result from a combination of inaccuracy of elevation and horizontal control for topography mapped at a scale of 1:250,000 and from erroneous station locations or elevations. Inner hand terrain corrections were available for a total of 3,150 data points in the WSRAA and the adjacent area. Terrain corrections were completed for the remaining 3,925 data points by using an option in the digital terrain correction program (Godson and Plouff, 1988) to roughly estimate the complete terrain correction from the data points to 166.7 km (103.6 mi) only with the 1:250,000 digital terrain model. The error from only using the computer estimated based on 1:250,000 digitization will be discussed in the section on "Suggested improvements of data quality."

Small location errors are magnified if terrain corrections are done wholly by computer, because data points can be re-positioned into a fictitious locations within the terrain model, which can be apparently suspended in air, buried, or closer or farther from nearby terrain. If plotted locations and elevation of data points were uncertain, access seemed reasonable, and distances from other data points were greater than, for example, 5 km (3 mi), these data points were accepted. If locations and elevations could not be reconciled with topography and reasonable access, including helicopter access to spot elevations on hilltops, data points were discarded. Also, data points were thinned so that terrain dependent gravity anomalies would not be created for closely spaced points in areas with significantly varying terrain corrections and doubtful locations.

## GRAVITY ANOMALIES

Theoretical values of gravity at sea level were calculated as a function of latitude by using the Geodetic Reference System 1967 formula (GRS-67) for normal gravity on the spheroid (International Association of Geodesy, 1971, p. 60). The theoretical value of gravity was adjusted to the elevations of data points by using Swick's (1942, p.65) standard formula for the free-air correction. Free-air gravity anomalies were calculated by subtracting the theoretical gravity values from the observed gravity values. Complete Bouguer anomalies were calculated by taking into account the effect of the mass of rocks with assumed average densities of 2.67 g/cm$^3$ between the station and sea level (Bouguer correction), Earth curvature, and departures of topography from the station elevation (terrain correction). Oliver (1980, p. 50) listed formulas used by the U.S. Geological Survey to calculate gravity corrections.

The effect of isostatic compensation was estimated by using the method of Jachens and Roberts (1981). The gravity effect of Airy-Heiskanen compensation (Heiskanen and Vening Meinesz, 1958, p. 135-137) was calculated for each data point by summing the gravity effects of mass deficiencies of volume elements ("roots") of crustal density that penetrate into denser rocks beneath the base of the normal crust to compensate for overlying rock above sea level. The same 3-minute digitization of topography applied to gravity terrain corrections provided model elements to 166.7 km from each data point. Assumed isostatic parameters are 25 km for the thickness of normal crust, 2.67 g/cm$^3$ for the average density of rocks above sea level, and 0.4 g/cm$^3$ for the contrast in density between the lower crust and the upper mantle. Assumptions are that compensation can occur locally, that the mass and lateral dimensions of the compensating volume element at the base of the crust are the same as the volume element of topography at the surface, and that the mass of the volume element at the base of the crust can be treated as though it is concentrated along a centered vertical line element. The consequent height of the volume element at the base of the crust is ratio of 2.67/0.4 times the average elevation of the topographic element above sea level. 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 previously published gravity maps (Plouff, 1992). Adjusting elevations of elements of the isostatic model for the effect of the Earth's curvature would add about 1 mGal to the value calculated for isostatic residual gravity. Gravity values for isostatic compensation of the mass above sea level beyond 166.7 km were interpolated from maps by Karki and others (1961), which applied an assumed normal crustal thickness of 30 km. Different compensating models and different parameters would result in gravity datum shifts and gradual changes of values with distance, and, therefore, would not cause significant changes of the anomaly pattern on the isostatic residual gravity map.

## DATA SET COMPILED IN 1994

A preliminary gravity map (Doebrich and others, 1994, fig. 20) was prepared for an initial set of gravity data obtained from a statewide compilation of Nevada by Saltus (1988b), C.R. Roberts (written commun., 1990) and Snyder and others (1982) in California, Plouff and others (1976), and Plouff (1987, 1994). Most of the data from Saltus (1988b) was otained from the National Geophysical Data Center (1984) and other published sources. To preserve the identity of original data sources, original data later were recovered from the National Geophysical Data Center (1984, 1991) and other published sources to replace all except 355 data points from Saltus (1988b).

## DATA FROM THE NATIONAL GEOPHYSICAL DATA CENTER

The National Geophysical Data Center (U.S. Department of Commerce, National Oceanic and Atmospheric Administration) in Boulder, Colorado, initially acquired gravity data from the Defense Mapping Agency (DMA) Gravity Library and continues to enlarge this data base. A total of 8,002 data points available in digital format from the National Geophysical Data Center (1991) (NGDC) covers the WSRAA and a band extending as far as 30 km outward. A total of 6,122 NGDC data points are located within the approximate boundary of the WSRAA.

Data from Griscom and Conradi (1976), Snyder and others (1982), and Plouff (1987) form the gravity database for the part of the study area in California. Data in digital format from NGDC supplement data in computer files of the U.S. Geological Survey in Menlo Park, California, to cover the part of the study area in Nevada and Oregon. A total of 5,576 data points from NGDC are located in the Nevada part of the WSRAA (table 2). About 457 of these data points are redundant because they are 0.05 minute or closer to other data points, have elevations within 4 ft of those data points, and usually have closely-matching values of observed gravity. Most of the redundant points that needed to be discarded were data points from earlier observers, which were apparently obtained from Defense Mapping Agency by later compilers, who re-submitted the absorbed data to the DMA as part of a comprehensive collection. Source #3891 (table 2) apparently has 19 data points absorbed from older sources, source #5069 has 142 data points with changed station identifications absorbed from older sources, source #6625 has 55 absorbed data points with no station identifications, and source #7358 has 120 absorbed data points with unchanged station identifications. Data from the NGDC, which are not discussed separately in other sections of this report, are in files DMALOV.ISN, DMAMCD.ISN, DMAMIL.ISN, OREG95.ISN, RENO95.ISN, DMAVYA.ISN, and SIKORA.ISN.

As discussions of individual data sets within the NGDC/DMA library of gravity data will indicate in other sections of this report, one needs to treat the data cautiously. The DMA applied constant datum shifts of observed gravity to surveys that covered extensive areas, whereas detailed analyses may suggest application of locally variable datum shifts. The data have no better quality than provided by the contribuors to the library and, in addition, are vulnerable to misunderstanding and typographical errors. An example of misunderstanding as well as lack of quality control in the 1970's is a data set, for which a contributor provided elevations in metric units, but the DMA apparently assumed the elevations were in feet and mistakenly multiplied the elevations by 0.3048 to convert to metric units. Another error by a contributor or the DMA is a NGDC data point that plots near an island in Pyramid Lake, Nevada, but should be located exactly one degree to the east. NGDC (1984, 1991) format does not include flags for data later reported as erroneous.

A common problem in associating data points with values published by contributors is that NGDC data point identifiers are restricted to four digits, but blank spaces or ambiguous leftmost digits rather than rightmost digits were saved by the DMA. I created 8-digit station names/identifications for NGDC data (in diskette files with names with a prefix of "DMA") by appending their 4-digit sequence numbers to their 4-digit codes that identify the data source. For ease of recognizing data sources and reducing the number of characters for plotting, I replaced most DMA source codes with a right-adjusted letter in the fourth digit of the 8-digit station name (table 2). Station names generally were retained in their original form, but a prefix, "E," was substituted in column 1 of the station name for data points, for which NGDC elevations were corrected by 2 m (6 ft) or more and a prefix, "L," was substituted in column 1 or 2 of the station name for data points, for which NGDC locations were corrected by 0.02 minute or more. Arbitrary station names were assigned to data points that lacked unique sequence numbers.

Subsets with NGDC source numbers 3507, 3578, and 3598 (table 2) were excluded because they do not form useful clusters with ties to other stations, and sources for their elevations and reliabilities of their local gravity base stations are unknown. Subsets in Nevada from the U.S. Geological Survey with source numbers 2235, 4787, 4788, 4834, 4869, 4933, 5018, 5019, 5020, 5675, 5869, 5962, 6948, 6976, 7358, 7567, 7838, and 7942 will be discussed in later sections of this report. Only one set of data from the U.S. Geological Survey, source #2179 (Mabey, 1960), are retained as part of the NGDC set, inasmuch as no raw data or principal facts have been found for these data. Within the limitation of standard deviations that exceed 0.5 mGal for numerous ties (Plouff, 1977b, p.35; Plouff and others, 1976, p.5; Wagini, 1985, p. 15; and Plouff, 1994, p. 14), no consistent change of observed gravity could be applied to NGDC source #2179. Subsets with source numbers 3046, 3891, 4999, 5069, 5503, and 6625 were extracted from the NGDC digital data set and will be discussed in other sections of this report. The remaining data identified as part of the NGDC set consist of files DMALOV.ISN, DMAMCD.ISN, DMAMIL.ISN, and DMAVYA.ISN and are within files OREG95.ISN, RENO95.ISN, and SIKORA.ISN (Winnemucca quadragle).

Redundant data points that reflect independent gravity observations, although discarded, provide useful information to evaluate consistent observed-gravity datum shifts between data sources. If standard deviations were sufficiently small, constant values of observed gravity based on ties to observations by the U.S. Geological Survey or to data points from other sets were added as datum shifts to improve compatibility. The following datum shifts were determined in the Reno 1° by 2° quadrangle by Plouff (1994) and, except for the California part and the Winnemucca 1° by 2° quadrangle (Wagini, 1985), were applied to the rest of the study and adjacent areas. A datum shift of 0.55 mGal was subtracted for data from source #2649 and 0.10 mGal was subtracted (also Plouff, 1976) for data from sources #5116 and #5130. Numerous ties indicated that no consistent datum shift should be applied to observed-gravity values in source #2179 although 0.25 mGal was added to observed-gravity values in the Tonopah 1° by 2° quadrangle to the southeast of the study area (Plouff, 1990, table 2). Many location corrections were made and a few elevation corrections were made for NGDC data in addition to the above-mentioned observed-gravity datum shifts.

Gravity data collected by the U.S. Geological Survey and the California Division of Mines and Geology (Chapman, 1966) before about 1975 were tied to the observed-gravity datum of Woollard (1958) and Woollard and Rose (1963) at base stations usually located near airports. Schwimmer and Rice (1969) later described an observed-gravity datum for the U.S. National Gravity Base Net (NGBN), which was used as the observed-gravity datum for values of major DMA base stations (table 4) described by Jablonski (1974). Cogbill (1979, p. 193) referred to the NGBN datum as the "Potsdam datum," but Woollard (1979, p. 1352) probably used the name "Potsdam" (East Germany) for the Woollard and Rose (1963) datum. Values of observed gravity for the NGBN datum are about 0.8 mGal lower than the datum used by Woollard and Rose (1963), apparently leading to uncertainty in converting observed-gravity datums for some data sets in the gravity library to the current datum of observed gravity. The current datum of observed gravity for data obtained from the National Geophysical Data Center (1984, 1991) is that of the International Gravity Standardization Net of 1971 (IGSN-71) described by Morelli (1974). After about 1974, gravity surveys by the U.S. Geological Survey were tied to DMA base stations adjusted to the NGBN (for example, gravity surveys supervised by D.L. Peterson, Denver, Colo.) and IGSN-71 (for example, gravity surveys supervised by Donald Plouff, Menlo Park, Calif.) datums. To merge contributed gravity data sets with the IGSN-71 observed-gravity datum, the DMA applied constant datum shifts (table 2). DMA applied a constant datum shift of 14.52 mGal to most gravity data collected by the U.S. Geological Survey in California, whereas Snyder and others (1982) applied a variable datum shift defined as a function of observed gravity (Oliver, 1980, p. 51). In the following detailed discussions of observed-gravity datums for contributors to the NGDC database, it is assumed that the IGSN-71 datum is about 13.7 to 13.9 mGal lower than the NGBN datum and about 14.4 to 14.6 mGal lower than the Woollard datum.

## DATA COMPILED OR COLLECTED BY U.S. GEOLOGICAL SURVEY BEFORE 1993

### Study of Carson Sink

Wahl and Peterson (1976) collected gravity data for a study of Carson Sink in the Lovelock and Reno 1° by 2° quadrangles (file WAHLLOV.ISN and in file RENO95.ISN). The data were obtained in digital format from NGDC source #2235 for a study of the Reno quadrangle and were supplemented by typing principal facts (and adjusting the observed-gravity datum) for data in the report by Wahl and Peterson (1976) but not in NGDC source #2235 (Plouff, 1994). The prefix "S" was substituted for the number 2235 for station identification. The number one was placed ahead of station numbers for data collected in 1975 by D.L. Peterson to differentiate those numbers from data collected by R.R. Wahl in 1963-1964. Data collected in 1975 later became available in NGDC source #7942. Locations of most data points were validated or corrected by using current topographic maps.

The DMA applied a correction of -14.58 mGal to 1963-1964 data in source #2235 and a correction of -13.70 mGal to 1975 data in source #7942 compared to values published by Wahl and Peterson (1976). Evaluation of previous ties made in the Reno quadrangle (Plouff, 1994) and a tie made June 20, 1993 (file BLM938.FLD) between the DMA primary base station at the Fallon, Nevada airport and the site of Wahl's primary base station, "SFALL", (R.R. Wahl, written commun., 1988), provided the basis for subtracting 14.17 mGal from the published values in the Reno quadrangle instead of the NCDC values. A comparable datum shift of 14.18±0.11 mGal was obtained from a best fit of observed gravity for ties to 22 other data points collected in 1987-1988. Ties in the Lovelock quadrangle, however, led to subtracting 14.23 mGal in the Lovelock quadrangle. It is not known if the site of R.R. Wahl's base station near the Lovelock Post Office still exists to be tied to the DMA base station at the courthouse for further improvement of the quality of observed gravity.

Field data obtained from R.R. Wahl (written commun., 1988) for gravity data collected in 1961-1964 in and adjacent to the Reno quadrangle were typed into computer files (Plouff, 1994). Inasmuch as details of data analysis, including possible later ties, are not known to me, the field data were not reduced to revise values of observed gravity but were used to evaluate data accuracy and to identify values that might significantly differ from the published values. For example, four presumed mis-readings of 100 dial units and one mis-reading of 300 dial units were corrected before the 1976 publication. Comparisons with values of observed gravity at data points common to other gravity surveys indicated that the instrument multiplicative factor shown on the data sheets for Worden gravity meter readings was correct to within 0.8%. Instrument drift curves indicated that the Worden gravity meter E340 used in 1963-1964 had high drift rates between resets of 1.1 mGal/day for 27 days in 1963 and 1.45 mGal/day for 16 days in 1964.

### Geothermal studies

Gravity surveys were conducted by the U.S. Geological Survey as part of geologic evaluations of areas with potential geothermal resources (Peterson and Dansereau, 1975; Plouff and Conradi, 1975; Griscom and Conradi, 1976; Peterson and Hassemer, 1977; Peterson and Hoover, 1977; Peterson and Kaufmann, 1978a, b, and c; Schaefer and Maurer, 1980; and Duffrin and others, 1985). The difference of observed gravity between values for the NGBN and IGSN-71 datums at the DMA base station in Gerlach, Nevada is reflected by the 13.79-mGal (table 4) datum shift applied to obtain NGDC sources #4834 (Peterson and Dansereau, 1975) and to obtain sources #5018, #5020, and #5019 (Peterson and Kaufmann, 1978a, b, and c). The datum shift of 13.70 mGal to obtain data sources #4869 (Peterson and Hoover, 1977) and #4933 (Peterson and Hassemer, 1977) does not agree with a datum shift of 13.76 mGal for the authors' stated DMA base station at Denio, Nev. (table 4). Therefore, I applied a datum shift of 13.76 mGal to the data from Peterson and Hoover (1977) near Baltazor Hot Springs for the present compilation. I applied a datum shift of 13.90 mGal, however, to the data of Peterson and Hassemer (1977) near Pinto Hot Springs based on my tie (station P856) to their local base station (PS01) near a benchmark. Original station identifications were recovered from reports by D.L. Peterson and co-authors to replace short non-unique versions of station identifications in associated NGDC sources. The above sets of data are in files GEOTHLOV.ISN and GEOTHVYA.ISN.

Plouff and Conradi (1975) provided a tie to the Klamath Falls DMA base station (table 4) to suggest a datum shift of 0.81+13.70=14.51 mGal between their stated Chapman (1966) datum and IGSN-71 for the Crump Geyser area inWarner Valley, Oregon, adjacent to the northwest corner of the WSRAA. The DMA, however applied no datum shift to their values of observed gravity to obtain NGDC source #4911. Plouff (1977b) applied a datum shift of 14.48±0.1 mGal in 1977, but later evaluation of indirect ties in Oregon and Nevada indicated a datum shift of 14.54 mGal to obtain values of observed gravity for the Crump Geyser data in file OREG95.ISN.

The values of observed-gravity listed by Griscom and Conradi (1976) for their geothermal study of Surprise Valley, California, are on the NGBN datum, inasmuch as header lines in their published computer printout indicate that the assumed value at Chapman's (1966) Alturas, California, base station is 979,887.95 mGal, which is 13.65 mGal higher than the value for the IGSN-71 datum (table 4). Therefore, 13.65 mGal was subtracted from values of observed gravity listed by Griscom and Conradi (1976), to convert to the IGSN-71 datum (file GRISCOM.ISN). Differences ranging from 13.3 to 13.9 mGal for close ties of Griscom-Conradi data to 16 independently collected data points from Snyder and others (1982) provide an independent verification of this datum shift. In absorbing ten Griscom-Conradi data points into their data set, Chapman and others (1977, p. 14) apparently assumed that the listed Griscom-Conradi values of observed gravity were on the Woollard datum, which would require a subtraction of about 14.5 mGal to convert to IGSN-71. This error persisted in data sets of Snyder and others (1982) and NGDC source #4735.

Schaefer and Maurer (1980) participated in a geothermal study in the western arm of the Black Rock Desert, Nevada (files BLACKLOV.ISN and BLACKVYA.ISN). The DMA subtracted 12.79 mGal from their listed values of observed gravity to convert to the IGSN-71 datum for NGDC source #5869. Apparent direct ties and indirect ties to other data sets indicate that 1.0±0.1 mGal should be subtracted from the values of observed gravity in NGDC source #5869. Inasmuch as the difference between the NGBN and IGSN-71 datums at the base station in Gerlach, Nevada, is 13.79 mGal, it is assumed that a typographical error was made by the DMA in converting datums. Therefore, I subtracted 1.0 mGal from values of observed gravity in source #5869. I replaced the source #5869 by " B" in station names but did not recover original station numbers from Schaefer and Maurer (1980). I corrected an incorrectly typed gravity reading on a field sheet (D.H. Schaefer, written commun., 1986) to correct an error of 700 units (67.55 mGal) for helicopter station "B93" (originally "BRK22"), which is not included in the 1991 version of NGDC source #5869.

Duffrin and others (1985) conducted a gravity survey of the Humboldt House Geothermal Area, Nevada (file HOUSELOV.ISN). The authors stated that Loran navigation was used to determine most locations, and altimetry or topographic contour interpolation--supplemented by surveying for peripheral bedrock locations--was needed to determine most elevations. The DMA subtracted 28.55 mGal from their listed values of observed gravity to convert to the IGSN-71 datum for NGDC source #6976. I added 0.35±0.06 mGal to the NGDC values of observed gravity based on ties to four data points from R.R. Wahl's data set and deleted four embedded data points from other NGDC sources, which indicated that 0.5 to 5.0 mGal should be added. Locations of all data points were re-digitized on presently available maps, inasmuch as there apparently are consistent 0.3-minute location errors for many data points, juxtapositions of some benchmark elevations with locations (data points HH20-28), and elevation datum shifts (data points HH72-92). A total of 90 data points from the original data set of 168 were reconciled and saved.

## Study of McDermitt area

Donald Plouff (1976, 1977a) conducted a gravity survey to delineate caldera system near McDermitt, Nevada and the adjacent area in Oregon (in files PLOUFMCD.ISN, OREG95.ISN, and PLOUFVYA.ISN). Based on direct ties to the DMA McDermitt base station (table 4), the datum of observed gravity was converted by Plouff (1977b) to the IGSN-71 datum by subtracting 14.50 mGal from the originally published values. NGDC source #4788 has the same values of observed gravity. To differentiate these data from another set of data in the McDermitt quadrangle, the prefix "MCP" was substituted for the original prefix "MCD" for station names.

## Study of the Osgood Mountains area

Abrams and others (1984) collected gravity data as part of comprehensive geophysical studies of the Osgood Mountains in the McDermitt and Winnemucca quadrangles (in files OSGDMCD.ISN and SIKORA.ISN). Their data were absorbed into the NGDC data base as source #6948 without changing their values of observed gravity.

## Regional aquifer studies

The Water Resources Division of the U.S. Geological Survey collected and interpreted gravity data in basins and valleys in the study area (Schaefer and others, 1984; and Schaefer and others, 1985). The small variation of the datum shift applied by the DMA, 13.7±0.1 mGal, to values of observed gravity in Dixie Valley, Nevada (Schaefer and others, 1984), indicates that the DMA obtained data from the authors, which was slightly different than the values of observed gravity in their publication. Wagini (1985) accepted the values of observed gravity from source #5962 for the Winnemucca quadrangle but modified most locations (file SIKORA.ISN). I obtained data in digital format from D.H. Schaefer (written commun., 1986), which have values of observed gravity in source #5962 plus a constant 13.70 mGal, but, for compatibility with other data in the Reno quadrangle, I subtracted 0.2 mGal from values in source #5962 (file RENO95.ISN). I also subtracted 0.2 mGal from values for source #5962 in the Millett quadrangle (file WRDMIL.ISN).

Schaefer and others (1985) conducted a gravity survey of Paradise Valley in the McDermitt quadrangle, Nevada (file PV.ISN). The DMA subtracted 8.00 mGal from their values to obtain NGDC source #7567. Redundancy tests yielded inconsistent differences between their data and nearby data points. Digital gravity terrain corrections yielded significant differences ranging to 5 mGal between their data and nearby data points. Plotting their data on a topographic map with significant terrain correction disagreements revealed revealed that their data points should be translated about ½ mile (1 km) west-northwest to corectly register their station elevations with topography in that area, thereby correcting elevation errors up to 200 ft (60 m). D.H. Schaefer (written commun., 1995) provided two maps with gravity station locations, which verified that 28 of 29 data points with a station name prefix of "G" on the Hot Springs Peak 15' topographic map should be translated 0.14±0.05' north and 0.71±0.13' west, but none of the stations with a prefix "WF" on the Fliss 15' topographic map should be consistently translated. Applying that approximate translation to 51 well defined points on all

7½' topographic maps improved the needed translation to 0.13±0.04' north and 0.69±0.07' west for stations G47A to G143, but no significant translation was needed for lower-numbered G-stations. Ties to five data points from other sets indicated that 1.70±0.04 mGal should be subtracted from values of observed gravity in NCDC source #7567 for WF-stations. Ties to 11 data points from other sets indicated that 0.4±1.2 mGal should be added to values of observed gravity in NCDC source #7567 for low numbered G-stations, but, based on eight of those points, 1.0±0.3 mGal should be added. Therefore, accepting an error of about 1.0 mGal, 0.70 mGal was added to the NCDC values for stations G007 to G038. Based on 13 ties to other data sets, a datum shift of 8.0 mGal (8.1±0.6 mGal) was added to the NCDC values for stations G049 to G137, thus obtaining the original published values.

### U.S. Geological Survey studies of public lands and State cooperative studies

Donald Plouff (1987, 1994) conducted gravity surveys for the evaluation of mineral resources of Roadless Areas, the Pyramid Lake Indian Reservation, and the Reno one- by two-degree quadrangle in and adjacent to the WSRAA (files PLOUFLOV.ISN, PLOUFMCD.ISN, OREG95.ISN, RENO95.ISN, PLOUFVYA.ISN, and PLOUFWIN..ISN). Alexander Wagini (1985) explained in detail the shifts of observed gravity needed for individual data sets and the rationale to compile a gravity map of the Winnemucca 1° by 2° quadrangle in cooperation with the State of Nevada (file SIKORA.ISN). The DMA or NGDC applied no datum shift to obtain NGDC source #7358 from the values listed by Wagini (1985). Glen and others (1987) conducted a gravity survey along a long seismic line in cooperation with the State of Nevada (files PASSCLOV.ISN, PASSCMIL.ISN, and PASSCWIN.ISN). The DMA or NGDC applied no datum shift to obtain NGDC source #7838 from the values listed by Glen and others (1987).

### Compilation of gravity data in Nevada by R.W. Saltus

Data from the statewide gravity data compilation by Richard W. Saltus (1988) of the U.S. Geological Survey, which apparently are not accounted for in other files that I have found nor in NGDC data sets, are in files SALTMCD.ISN and SALTWIN.ISN. Most of the data may be part of gravity surveys conducted by the University of Nevada.

## DATA COLLECTED BY U.S. GEOLOGICAL SURVEY IN 1993

One purpose of this gravity survey was to substantially improve data coverage of the Vya 1° by 2° quadrangle in an area of sparse coverage centered at Desert Valley. In addition, the gravity survey was expected to provide data to estimate the thickness of sediments in Desert Valley, to delineate gravity gradients reflecting block faulting within and along the edges of the valley, and possibly to relate the regional gravity framework to localization of mineral deposits in nearby mining districts. A total of 258 gravity stations were established during July, 1993.(in files PLOUFLOV.ISN, PLOUFMCD.ISN, PLOUFVYA.ISN, and PLOUFWIN.ISN). A total of 14 previously established stations were reoccupied. The gravity data were tied to the DMA base station at the Winnemucca airport (table 4). A local base station "WNBAS," described as follows, was established in Winnemucca:

1 ft (0.3 m) southeast of the southeast corner of the Winemucca City Hall (former Post Office) at the north corner of Fourth and Melarkey Streets. About 13½ ft (4.1 m) southeast of and 0.7 ft (0.2 m) below benchmark K18-RESET on the vertical northeast face of building. Southwest edge of sidewalk. Observed gravity 979,827.51±0.03 mGal.

Following a suggestion by Plouff (1977, p. 4), a tie was made to a previously established base station in Orovada (Plouff, 1976, p. 3), Nevada. Future access to the site near the pump area of a service station, however, was discouraged by the presumed owner of the property. The new value is 979,872.96±0.04 mGal relative to the Winnemucca local base station compared to the previous 979,873.04±0.06 mGal (Plouff, 1977, p. 17) relative to the base station at McDermitt, assuming a datum shift of 14.50 mGal relative to the Woollard (1958) datum. Without repeating other data points of the McDermitt gravity survey, it is uncertain how this change--if significantly greater than tectonic or groundwater changes during the intervening years--can be incorporated in re-reduction of the 1970's McDermitt gravity survey.

## DATA COLLECTED BY A.H. COGBILL, JR. OF NORTHWESTERN UNIVERSITY

Cogbill (1979) collected gravity data in an extensive region of western Nevada as part of a study of regional crustal structure (in files COGBLOV.ISN, COGBMCD.ISN, RENO95.ISN, COGBVYA.ISN, and COGBWIN.ISN). Principal facts and gravity station descriptions obtained from Cogbill (written communs., 1987, 1988, and 1994) supplied correct station names for NGDC source #4999 and helped to correct locations and to provide accuracy codes. Wagini (1985, p.

16) stated that the DMA subtracted 13.90 mGal from values of observed gravity submitted by Cogbill (1979). Empirically-defined shifts of the NGDC datum of observed gravity applied to values in source #4999 varied among the one- by two-degree quadrangles. A constant of 0.10 mGal, based on 0.15±0.21 mGal for eight ties, was added in the Reno quadrangle (Plouff, 1994). A constant of 0.20 mGal, based on ties to data in the adjacent Reno quadrangle, was added in the Lovelock quadrangle. A constant of 0.25±0.12 mGal based on 15 ties was added in the McDermitt quadrangle. A constant of 0.50±0.07 mGal, based on 10 ties to data from Plouff (1977b; 1984; Plouff and others, 1976) at benchmarks, was added in the Vya quadrangle. No datum shift was applied for the one data point retained in the Winnemucca quadrangle.

## DATA COLLECTED BY R.A. CREWDSON OF THE COLORADO SCHOOL OF MINES

R.A. Crewdson (1976) conducted a gravity survey as part of a comprehensive geophysical study of the Black Rock Desert (file CREWLOV.ISN). Based on a five ties to Cogbill (1979) data (1.07±0.02 mGal) and the expected difference of about 0.8 to 0.9 mGal between the Woollard (1958) and the NGBN datums, 0.9 mGal was subtracted from Crewdson's NGDC source #5503 data. Crewdson's (1976) thesis showed station locations, but the scales were too small to accurately transfer locations to present published 1:24,000 maps.

## DATA COLLECTED BY R.K. EDQUIST OF THE UNIVERSITY OF UTAH RESEARCH INSTITUTE

Edquist (1981) conducted a gravity survey in behalf of the Department of Energy, which covers an area of about 750 $km^2$ in and near the Baltazor Hot Springs Known Geothermal Resource Area and the Painted Hills thermal area, Nevada (file EDQUIST.ISN). NGDC data source #6625 was obtained from his report, which includes previously established data from sources #4787 and #4869. No station/sequence numbers were included in source #6625, making it difficult to recover the original station numbers to check locations and to establish that NGDC subtracted 14.50 mGal from his values of observed gravity. Based on three apparent ties of 0.69, 0.74, and 0.78 mGal, I added 0.74 mGal to the values of observed gravity in source #6625, in effect subtracting 13.76 mGal from Edquist's (1981) values, which is the difference between the NGBN and IGSN-71 observed-gravity datums at the nearby Denio base station (table 4).

## COMPILATION AND DATA COLLECTED BY THE UNIVERSITY OF NEVADA

In behalf of the University of Nevada in Reno and the Nevada Bureau of Mines and Geology, J.W. Erwin supervised collection of gravity data near Battle Mountain, Nevada (source #3046), and for preparation of a statewide gravity map (sources #3891, #5068, #5069, and #6126). The U.S. Geological Survey cooperated in this work by collecting, reducing, and compiling gravity data and by providing the method of digital gravity terrain correction. Substantial parts of Erwin's data in NGDC files consist of re-numbered station names and possible location changes for data from earlier NGDC sources. The DMA subtracted 13.75 mGal from Erwin's (1982) values of observed gravity to obtain source #5069 for the Reno quadrangle. Plouff (1994, p. 8) added 0.10 mGal ( 0.2±0.2 mGal for 22 ties) to values of observed gravity in source #5069 (data points with prefix "E" in file RENO95.ISN). Wagini (1985, p. 14) added 0.11 mGal to values of observed gravity in source #3046 based on two reoccupied data points and a discrepancy of the DMA datum adjustment. Based on 28 reoccupied data points and 68 other ties in the Winnemucca quadrangle, Wagini (1985, p. 14) subtracted 0.61 mGal from values of observed gravity in source #3891 (in file SIKORA.ISN). The data point in source #6126--associated with the Wells quadrangle--was discarded. The observed-gravity datum was not changed for four data points, which were not previously occupied, in NGDC source #5068 for the Millett quadrangle (in file DMAMIL.ISN).

## COMPILATION OF DATA IN DIRECTORIES FOR OREGON AND IN 1° BY 2° QUADRANGLES

### Oregon

The data in the Oregon directory (file OREG95.ISN) are located outside the WSRAA but contribute to gridding and contouring adjacent parts of the WSRAA. In order to fill a gap in the northwest corner of the study area, data coverage was needed to latitude 42° 8' N. All except four data points are from files of Donald Plouff (1977b, 1987) and from the NGDC. Data from Plouff have station names with prefices P (Plouff, 1987), MCD (also #4788), SAR (also #4787), or WRN (also #4911). No observed-gravity correction needs to be added to sources #4787 and #4788, but 14.54 mGal should be subtracted from source #4911 for Warner Valley (Plouff and Conradi, 1975; Plouff, 1977b). A total of 26 data points with prefices #2531 (Oregon State University), #5023 (Oregon State University), "I" (#3945--DMA, 1973), "J" (#3946--DMA, 1973), and "O" (#2531) are from NGDC (1991).

Four data points also were obtained from P.F. Halvorson (written commun., 1994), formerly of the U.S. Geological Survey in Menlo Park, California, but are of unknown origin. Two data points have a prefix "3968," which is not an NGDC source number. The other two data points with prefices of "OWY" are located in southwest Idaho but were not recognized by D.M. Kulik (oral commun., 1996) of the U.S. Geological Survey in Denver, Colorado, as being a product of geothermal or roadless area studies near the Owyhee Reservoir. File DELETE ORE only includes data points excluded since 1990.

## Alturas 1° by 2° quadrangle

File GRISCOM.ISN is the first release in digital format of a thinned version of closely spaced data from Griscom and Conradi (1976). I determined inner terrain corrections to 500 m for these data. If redundant data are recovered from file DELETE.ALT, an observed-gravity datum shift of 0.87 mGal may need to be added.

File ALTXSV95.ISN is from Chapman and others (1977) with a conversion to the IGSN-71 datum by Snyder and others (1982). The datum shift of 14.46 to 14.54 mGal is specified in columns 76 to 80 for each data point. The DMA subtracted a constant of 14.58 mGal to obtain NGDC source #5675 from values listed by Chapman and others (1977), and, consequently, the Snyder observed-gravity values are about 0.1 mGal higher than the NGDC values. The DMA apparently had obtained an earlier version of values for stations with a prefix "AB," inasmuch as their conversion from the values listed by Chapman and others (1977, p. 13) is 14.25 mGal, resulting in values from Snyder being about 0.3 mGal lower than those of NGDC source #3382. The value of base station CH15 listed by Chapman and others (1977, p. 15) is 14.48 mGal higher than source #2665 and 14.50 mGal higher than Snyder and others (1982). For consistency, I re-computed digital terrain corrections, resulting in changes of less than 0.14 mGal compared to the hand-digitized terrain model of Chapman and others (1977). Data points embedded in the Griscom-Conradi data set and in the set of data points with prefices of "W" (California Department of Water Resources) were deleted. The prefix "SZ" refers to gravity data collected near the edge of the Susanville quadrangle. The prefix "H" refers to data from the Humble Oil Company. Chapman and others (1977) re-numbered and changed most longitudes for U.S. Geological Survey data in source #2713.

## Lovelock 1° by 2° quadrangle

The statewide compilation by Saltus (1988) was used in 1994 (Doebrich and others, 1994, fig. 20) to cover extensive areas not included in files from studies by Plouff (1987, 1994), which are not in the NGDC data set. A total of eighteen data points were collected in 1993. This part of the Saltus (1988) data set, however, was replaced in 1995 by the corresponding NGDC data points, because numerous data points had elevations that disagreed with interpolated terrain elevations by greater than 500 ft (150 m), re-calculated anomalies disagreed with the given anomalies to 6.5 mGal, or contour "bullseyes" occurred. Slight rounding errors may have occurred, however, in the replacement process.

As discussed previously, 1.0 mGal was subtracted from values of observed gravity in NGDC source #5962 derived from Schaefer and Maure (1980) to create file BLACKLOV.ISN. Data points with prefices "BRD" were discarded, because five points have values of observed gravity, which are about 13.9 mGal too low. Data point "B117" (40° 40.22' N lat, 119° 22.07' W long) was discarded in 1995 because the value of observed gravity is about 100 mGal too high; the data point did not appear as a contour "bullseye" in 1994 because it was masked by a nearly coincident correct data point as a result of a defect in the gridding and contouring algorithm.

The original station names were recovered and all locations were checked by using notes from A.H. Cogbill (written commun., 1984) so that the data points from source #4999 could be accepted, rejected, or corrected, to create file COGBLOV.ISN. Based on ties near the Reno quadrangle, a correction of 0.2 mGal was added to the observed gravity for source #4999 . Based on ties (0.87±02 mGal) to five data points from corrected source #4999, 0.9 mGal was subtracted from values of observed gravity for NGDC source #5503 obtained from Crewdson (1976), to create file CREWLOV.ISN.

Original station names were recovered and most locations were checked for U.S. Geological Survey geothermal studies in sources #4834, #5018, #5019, and #5020, to create file GEOTH.ISN. These data points superseded data points from source #5503 (CREWLOV.ISN) unless they were engulfed by the latter data set. Problems associated with creating file HOUSELOV.ISN from NGDC source #6976 for the Humboldt House Geothermal Area were discussed in the section, "Geothermal studies."

I typed principal facts for 61 stations from Wahl and Peterson (1976, p.11-13), which are not in source #2235. Ties to other data points in the NGDC database formed the basis for adding 0.35 mGal to the values of observed gravity in source #2235 (in contrast to adding 0.41 mGal in the Reno quadrangle), to create file WAHLLOV.ISN.

### McDermitt 1° by 2° quadrangle (MCD directory)

Computer programs were used in 1995 to substitute original NGDC data points (file DMAMCD.ISN) and to identify data points with gravity anomalies that disagree with re-computed values in the statewide digital compilation of Saltus (1988). Small rounding errors in Saltus (1988) data may have been retained, however, in the NGDC data recovery process. Separate files were created for data from Cogbill (1979) in source #4999 (file COGBMCD.ISN), data from the Osgood Mountains (Abrams and others, 1984) in source #6948 (a thinned set in files OSGDMCD.ISN), and from Paradise Valley (Schaefer and others, 1985) in source #7567 (file PV.ISN). Data points from Saltus (1988), which were not identified as NGDC data nor data from previous studies by Plouff (1977b, 1987), are in file SALTMCD.ISN. Most of the data in file SALTMCD.ISN probably are unpublished data collected by the University of Nevada for preparation of the gravity map of the McDermitt quadrangle (Erwin and others, 1985).

A.H. Cogbill (written commun., 1994) provided station names and location descriptions (mostly benchmarks) for data source #4999. Locations for 22 of 80 data points were corrected for source #4999, but only 11 location codes were included. A prefix "MCD" for data from Plouff (1977b) was changed to "MCP" in file PLOUFMCD.ISN to avoid station name duplication with names in file SALTMCD.ISN. The data from Plouff (1977b) are in NGDC source #4788 with no observed-gravity datum shift. File PLOUFMCD.ISN also includes two points from Plouff (1987) and 60 data points collected in 1993. Locations of data points and agreement between elevations and locations generally were not checked in the McDermitt quadrangle except in Paradise Valley and near the west edge of the quadrangle.

### Millett 1° by 2° quadrangle

The data in this quadrangle are located outside the WSRAA but contribute to gridding and contouring adjacent parts of the WSRAA. NGDC data points were recovered from the statewide compilation by Saltus (1988) to create file DMAMIL.ISN. Only four data points of 73 data points from NGDC source #5068 (from the University of Nevada) were retained, because the rest of the points nearly coincide with and probably were obtained from other data points in the NGDC data set. Files PASSCMIL.ISN ( source #7838) from Glen and others (1987) and WRDMIL.ISN (source #5962) from Schaefer and others, 1984) were extracted from DMAMIL.ISN. All locations were checked, and accuracy codes were assigned. Closely spaced data points from NGDC source #2179 in file DMAMIL.ISN and from file WRDMIL.ISN (from source #5962) were thinned, because locations are uncertain and, fictitious gravity anomalies reflecting this uncertainty could have been created.

### Reno 1° by 2° quadrangle

The data in file RENO95.ISN and their description are from Plouff (1994). The gravity effect of isostatic compensation was re-computed with a modified computer program, including the isostatic effect beyond 166.7 km. The maximum change of isostatic compensation was 0.16 mGal. Four sets of NGDC (1991) data in the Reno quadrangle not included by Plouff (1994) from NGDC (1984) are outside the study area.

### Susanville 1° by 2° quadrangle (SUSAN directory)

Four data points are from Plouff (1987) and 59 data points are from Robbins and others (1976; Snyder and others, 1982) in file SUSAN95.ISN. Only two data points in the latter data set (SZ16 and SZ22) are inside the WSRAA. The gravity effect of isostatic compensation was re-computed.

## Vya 1° by 2° quadrangle

The Vya quadrangle is the only one- by two-degree quadrangle wholly within the WSRAA. The most extensive set of data is from Plouff and others (1976), Plouff (1977b; 1987), and data collected in 1993, which are in file PLOUFVYA.ISN. Data from Plouff and others (1976) have station names with a prefix of "CS," data near McDermitt from Plouff (1977b) have station names with a prefix of "MCD," data from studies of roadless areas (Plouff, 1987) have station names with a prefix of "P," and data collected in 1993 have station names with a prefix of "WN." File ALTUR71.ISN consists of two data points from Griscom and Conradi (1976) with 13.65 mGal subtracted, as was discussed in the section about the Alturas quadrangle, and 18 data points from Snyder and others (1982). Data in and near the Black Rock Desert from Schaefer and Maurer (1980) are in file BLACKVYA.ISN. Cogbill's (1979) gravity data were extracted from NGDC source #4999 and were modified by recovering original station names and descriptions (A.H. Cogbill, Jr., written communs., 1987 and 1988) and by adding a datum correction of 0.50 mGal (file COGBVYA.ISN). Gravity data from Edquist (1981) werewere modified from NGDC source #6625 by recovering original station names and adding a datum shift of 0.74 mGal (file EDQUIST.ISN). Gravity data from Peterson and Hassemer (1977), Peterson and Hoover (1977), and Peterson and Kaufmann (1978a) are in file GEOTHVYA.ISN. The remaining data from the NGDC data set, which were not extracted are in file DMAVYA.ISN.

## Winnemucca 1° by 2° quadrangle (WINNE directory)

Most of the data are from Wagini's (1985; Sikora, 1991) compilation, which includes NGDC data (file SIKORA.ISN). Wagini (1985) corrected many NGDC locations and listed NGDC data that he deleted or were redundant. One data point from Cogbill (1979) was extracted from three data points in NGDC source #4999 (file COGBWIN.ISN). Data collected after Wagini's (1985) compilation include one data point from Glen and others (1987) in file PASSCWIN.ISN and data from Plouff (1987) and data collected in 1993, which are in file PLOUFWIN.ISN. A total of 10 data points, which do not duplicate data points in other sets, are from the Nevada compilation by Saltus (1988) (file SALTWIN.ISN). Prefices for station names in file SALTWIN.ISN are "4452" and "4453," which are not NGDC source numbers. Gravity data from Trexler and others (1981; 1982) in Pumpernickel Valley were not found.

## FILES WITH PRINCIPAL FACTS

Principal facts for each data point are contained in records of 80 characters in diskette files of Part B. The compact record format, which includes single-digit code characters and excludes decimal points, originally was designed for 80-column punchcards by the U.S. Geological Survey in Menlo Park, California (Plouff, 1977c, p. 14). The format for the present application is specified in the **README.** file on the diskette of Part B. Most data points judged to be redundant or doubtful in files with a prefix of **DELETE** may not include all variables and may extend past column 80 to accomodate an abbreviated explanation of the reason for deletion.

Preferably unique alphameric station names are in columns 1-8. Locations in columns 9-23 are in geographic coordinates expressed in degrees and minutes to the nearest 0.01 minute. Elevations in columns 24-29 are expressed to 0.1 ft. Values of observed gravity in columns 30-36 are expressed to 0.01 mGal. Although values of terrain corrections (inner part in columns 53-57 and total in columns 58-62), free air anomalies in columns 41-46, complete Bouguer anomalies in columns 64-69, and isostatic residual gravity in columns 70-75 are expressed to 0.01 mGal, most of those values are accurate to no better than 0.1 mGal. If available, a 4-digit code in columns 37-40 symbolizes the type of location and the estimated accuracies of elevation, location, and, if available, the value of observed gravity at each data point (table 3). 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 was left blank in the principal-facts tables unless the field data were available or the type of gravity meter was known. The radius, to which inner terrain corrections are carried, is specified by a one-digit code in column 63.

For the present application, dates (month-day-year), year of publication reference, or range of years when the last gravity observation, if available, are substituted for the simple Bouguer anomaly in columns 47-52. The 5-digit name of the base station, to which the station was tied, if available, is included in columns 76-80. 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.

The following statistical information summarizes principal facts for the 7,075 data points used to prepare the isostatic residual gravity map of the study area (fig. 3). Elevations range from 1027 to 2997 m (3,371 to 9,834 ft) above sea level with an average elevation of 1439±429 m (4,721±816 ft), where the last number indicates standard deviation. Values of observed gravity range from 979,404 to 979,948 mGal with an average of 979,803±65 mGal. Free-air gravity anomalies range from -81 to +133 mGal with an average of -8±26 mGal. Total terrain corrections range from -0.3 to 51.6 mGal with an average of 1.5±2.8 mGal. Complete Bouguer gravity anomalies range from -207 to -128 mGal with an average of -169±14 mGal. Values of isostatic residual gravity (fig. 3) range from -37 to +30 mGal with an average of -7±11 mGal. The ability to detect local gravity anomalies within the regional background has been improved by estimating the effect of isostatic compensation, as indicated by the reduction of the standard deviation by 3 mGal between Bouguer gravity anomalies and values for the isostatic residual gravity.

## FILES WITH FIELD DATA

Formats for files with field data are specified in the **README.** file on the diskette in Part B. Files of field observations with suffices **.FLD** may include gravity meter names, the last five digits of 8-digit station names, flags for repeated readings at data points from other surveys, dates, times, Greenwich time corrections, readings, station elevations, station elevation units, the first three digits of the accuracy code, a field terrain correction to 53 m (175 ft), a 5-digit code for the topographic map, and comments.. Files with suffices **.BAS** include values of observed gravity assumed or determined during the reduction process for base and repeat stations. Files for gravity meter calibrations with suffices **.CAL**, which cover the range of field readings, include a multiplication factor and a series of dial readings to the nearest 100 units with the associated series of milligal-equivalent values and interval factors.

## FILES WITH POLYGONS OF GEOGRAPHICALLY BASED BOUNDARIES

These files have three formats. Files with a suffix **.NAM** indicate the geographic coordinates of names of states to be plotted at scales of 1:500,000 (**STATE500.NAM**) and 1:2,000,000 (**STATEWH.NAM**). Files with a suffix **.OLN** ("other lines" format commonly used by the U.S. Geological Survey for computer programs in Menlo Park, California) specify geographic coordinates for one or more line segments including state lines (**STATESWH.OLN**), the part of the study area to display contours (**MARGIN3.OLN**) and the approximate WSRAA boundary without the Oregon state line (**95BNDRYU.OLN**). Files with a suffix of **.PLF** include the geographic coordinates of vertices of closed polygons that specify the approximate WSRAA boundary (**95BNDRY.PLF**) and the boundary for all data points included in the study area (**GATHER.PLF**).

## SUGGESTED IMPROVEMENTS OF DATA QUALITY

Verification or correction of data point locations and questions about values of observed gravity can be best resolved by obtaining information from original observers or their organizations. If this information is not available, plotting data points on published topographic maps so that locations and elevations can be verified, corrected, or deleted should be completed for locations indicated with bold print on figure 2. Data points from previously established NGDC data subsets with locations modified by Wagini (1985) should be flagged in file **SIKORA.ISN** by modifiying their station names. Filling data gaps and correcting uncertainties of observed gravity can be accomplished if data sets not in the present files, for example, data from oil companies, can be obtained or if new field data are collected.

The accuracy of gravity anomalies for 3,925 data points, which have terrain corrections based only on topography digitized at a scale of 1:250,000, can be improved either by completing inner hand terrain corrections to at least 500 m or preferably by developing a computer program to utilize available terrain digitized at a scale of 1:24,000 with a grid interval of 30 m (100 ft). Two methods can be used to estimate the error caused by roughly estimating the inner part of the terrain correction as a consequence of only using the 1:250,000 terrain model.

The first method is based on a comparison of the difference between inner hand terrain corrections and digital terrain corrections in the same range of distances with the difference between station elevations and linearly interpolated terrain model elevations (program STAELERR from Godson and Plouff, 1988). The comparison obtained in a test area was that hand terrain corrections were approximately 1.0 mGal higher than computer terrain corrections for each 30 m (100 ft) of elevation difference. Terrain correction errors estimated for 3.893 data points in the study area consequently range to 4.4 mGal (fig. 4). Data points with elevation differences that exceeded 150 m (500 ft) previously were discarded (Doebrich and others, 1994, p.17). The method of linear interpolation to determine elevations within the terrain model, however,

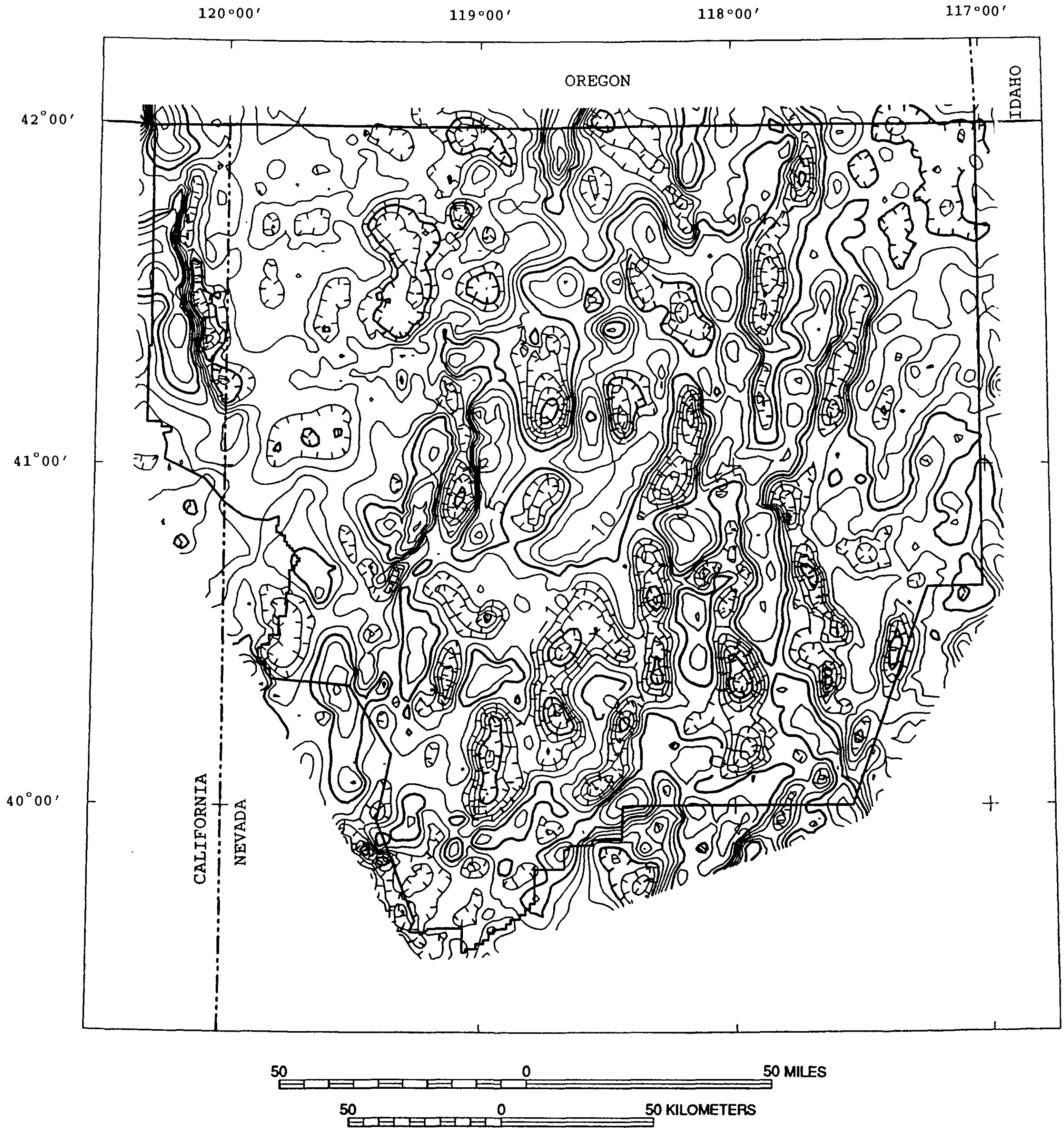


Figure 3.--Isostatic residual gravity map of the Winnemucca-Surprise Resource Assessment Area (WSRAA). Contour interval, 5 milligals. Hachures indicate closed gravity lows. Outermost thick line shows approximate border of WSRAA.

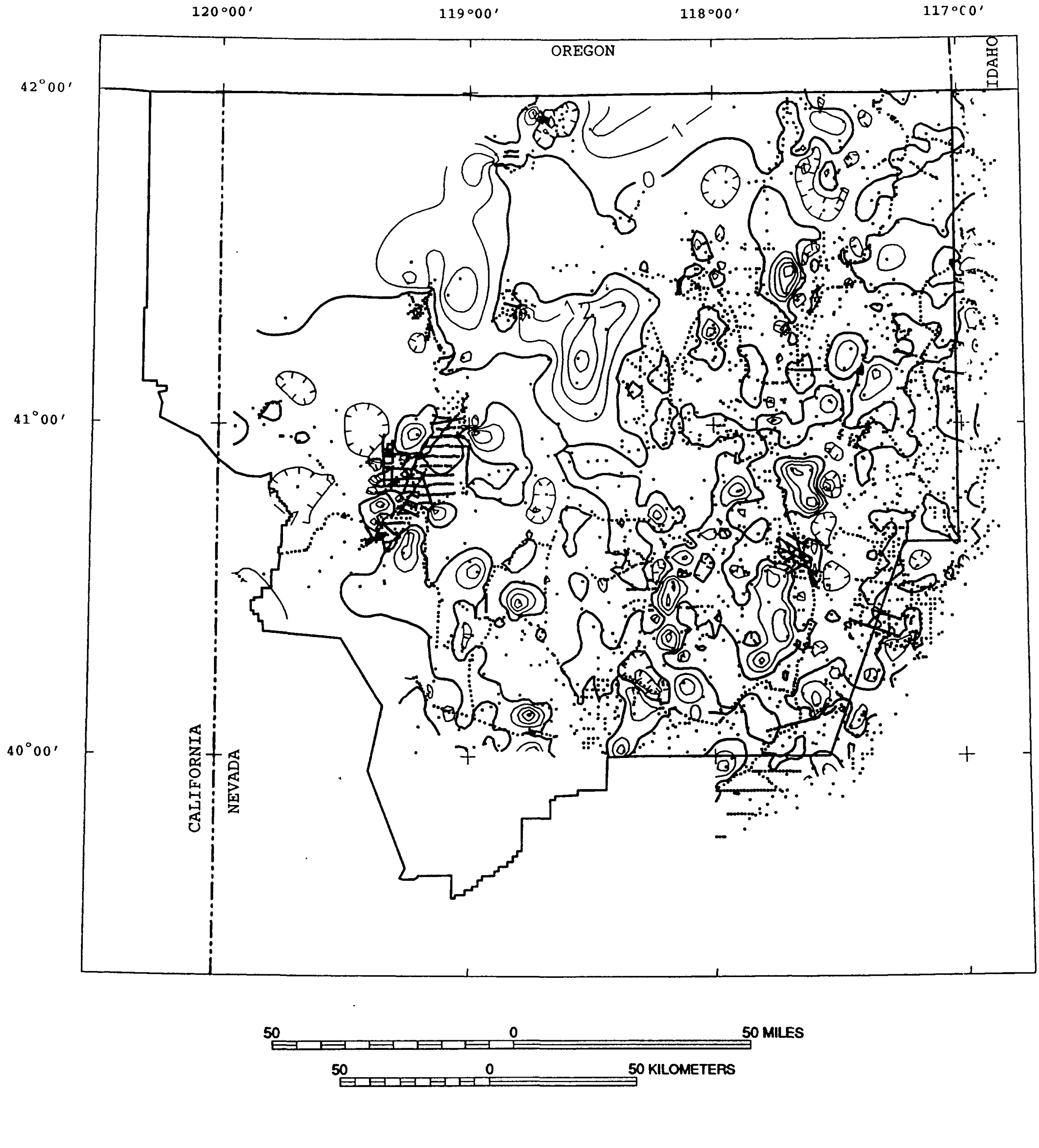


Figure 4.--Estimated error of gravity terrain corrections. Map shows elevations of data points minus linearly interpolated terrain elevations for 3,893 data points without inner hand terrain corrections. See text for explanation of method one for error estimate. Contour interval, hundreds of feet, with 100 ft approxima'ely equivalent to error of 1.0 mGal. Negative values, indicated by hachures, convert to positive values of te-rain correction errors to be added to values of isostatic residual gravity in figure 3.

probably yields larger elevation differences from station elevations than would be obtained by bicubic spline interpolation, for example. Inasmuch as finer terrain digitization has not been included in the present terrain model, the relationship between the terrain correction error and the misfit between the station elevations and the terrain model elevations cannot be precisely quantified to predict error. The priority for doing additional hand terrain corrections should be determined by a combination of the largest elevation differences obtained from program STAELERR and which data points are closely adjacent to data points that already have hand terrain corrections.

The second method to estimate the terrain correction error is to compute digital terrain corrections all the way to the station for data points that already have hand terrain corrections and to find the best least-squares fit between the two corrections. Plouff (1977b) determined that hand terrain corrections to a distance of 895 m (ft) were about 34% larger than computer terrain corrections for 305 data points. For 1,643 data points in the present study area, the best fit of hand terrain corrections versus computer terrain corrections yielded hand terrain corrections 5% larger than computer-equivalent terrain corrections, with a maximum error of 1.6 mGal. The smaller error in the present study area may be attributed to a smaller sampling of extreme terrain corrections and the use of a finer terrain grid interval of 15 seconds compared to the 30-second grid interval of Plouff (1977b).

## REFERENCES


Abrams, G.A., Moss, C.K., and Schutter, T.A., 1984, Principal facts for gravity stations in the Osgood Mountains, Humbol[d]t County, Nevada: U.S. Geological Survey Open-File Report 84-835, 211 p.

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.

Chapman, R.H., 1966, Gravity base station network: California Division of Mines and Geology Special Report 90 and Supplement, 53 p.

Chapman, R.H., Bishop, C.C., and Chase, G.W., 1977, Principal facts and sources for 1820 gravity stations on the Alturas 1°×2° quadrangle, California: California Division of Mines and Geology Open-File Report OFR-77-17, 53 p.

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.

_____1990, Gravity terrain corrections calculated using digital elevation models: Geophysics, v. 55, no. 1, p. 102-110.

Crewdson, R.A., 1976, Geophysical studies in the Black Rock Desert geothermal prospect, Nevada: Colorado School of Mines Ph. D. dissertation, about 200 p.

Doebrich, J.L., Albino, G.V., Barker, C.E., Duffield, W.A., Dunn, V.C., Hanna, W.F., McFarlan, J.P., McGuire, D.J., Miller, M.S., Peters, S.G., Plouff, Donald, Raines, G.L., Sawatzky, D.L., and Spanski, G.T., 1994, Resource assessment of the Bureau of Land Management's Winnemucca District and Surprise Resource Area, northwest Nevada and northeast California: U.S. Geological Survey Open-File Report 94-712, 101 p.

Duffrin, B.G., Berger, D.L., and Schaefer, D.H., 1985, Principal facts for gravity stations in the Humboldt House Geothermal Area, Pershing County, Nevada: U.S. Geological Survey Open-File Report 85-162, 11 p.

Edquist, R.K., 1981, Geophysical investigations of the Baltazor Hot Springs Known Geothermal Resource Area and the Painted Hills thermal area, Humboldt county, Nevada: University of Utah Research Institute Report DOE/ID/12079-29 ESL-54, 89 p.

Erwin, J.W., Ponce, D.A., and Wagini, Alexander, J.C., 1985, Complete Bouguer gravity map of Nevada--McDermitt sheet: Nevada: Nevada Bureau of Mines and Geology Map 86, scale 1:250,000.

Glen, J.M., Lewis, J.S., and Ponce, D.A., 1987, Gravity observations along a PASSCAL seismic line in west-central Nevada: U.S. Geological Survey Open-File Report 87-403, 10 p.

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.

Griscom, Andrew, and Conradi, Arthur, Jr., 1976, Principal facts and preliminary interpretation for gravity profiles and continuous magnetometer profiles in Surprise Valley, California: U.S. Geological Survey Open-File Report 76-260, 26 p., 5 figs., 3 sheets.

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

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 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.

Kärki, Pentti, Kivioja, Lassi, and Heiskanen, W.A., 1961, Topographic-isostatic reduction maps for the world for the Hayford Zones 18-1, Airy-Heiskanen System, T=30 km: Publication of the Isostatic Institute of the International Association of Geodesy, no. 35, 5 p., 20 pls.

Mabey, D.R., 1960, Regional gravity survey of part of the Basin and Range province, *in* Geological Survey Research 1960: U.S. Geological Survey Professional 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.

_____1991, DMA gravity file of the U.S. National Oceanic and Atmospheric Administration, Boulder, Colorado, CD-ROM.

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, D.A., 1975, Principal facts for a gravity survey in Gerlach and San Emidio Known Geothermal Resource Areas KGRA), Humboldt County, Nevada: U.S. Geological Survey Open-File Report 75-668, 6 p.

Peterson, D.L., and Hassemer, J.H., 1977, Principal facts for a gravity survey of Pinto Hot Springs Known Geothermal Resource Area, Nevada: U.S. Geological Survey Open-File Report 77-67-B, 4 p.

Peterson, D.L., and Hoover, D.B., 1977, Principal facts for a gravity survey of Baltazor Known Geothermal Resource Area, Nevada: U.S. Geological Survey Open-File Report 77-67-C, 4 p.

Peterson, D.L., and Kaufmann, H.E., 1978a, Principal facts for a gravity survey of the Double Hot Springs Known Geothermal Resource Area, Humboldt County, Nevada: U.S. Geological Survey Open-File Report 78-107-A, 5 p.

_____1978b, Principal facts for a gravity survey of the Fly Ranch Extension Known Geothermal Resource Area, Pershing County, Nevada: U.S. Geological Survey Open-File Report 78-107-C, 5 p.

_____1978c, Principal facts for a gravity survey of the Gerlach Extension Known Geothermal Resource Area, Humboldt County, Nevada: U.S. Geological Survey Open-File Report 78-107-B, 5 p.

Plouff, Donald, 1966, Digital terrain corrections based on geographic coordinates [abs.]: Geophysics, v. 31, no. 6, p. 1208.

_____1976, Principal facts for gravity observations near McDermitt, Nevada: U.S. Geological Survey Open-File Report 76-599, 21 p.

_____1977a, Gravity observations near McDermitt, Nevada during 1976: U.S. Geological Survey Open-File Report 77-536, 13 p.

_____1977b, List of principal facts and gravity anomalies for an area between Orovada, Nevada and Adel, Oregon: U.S. Geological Survey Open-File Report 77-683, 40 p.

_____1977c, 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.

_____1987, Gravity observations by the U.S. Geological Survey in northwest Nevada, southeast Oregon, and northeast California, 1984-1986: U.S. Geological Survey Open-File Report 87-639, 33 p.

_____1990, Principal facts for gravity data compiled for the Conterminous United States Mineral Appraisal Program, Tonopah 1- by 2-degree quadrangle, Nevada: U.S. Geological Survey Open-File Report 90-457, Part A, documentation, 22 p.; Part B, digital gravity data, diskette.

_____1992, Bouguer gravity anomaly and isostatic residual gravity maps of the Reno 1° x 2° quadrangle, Nevada and California: U.S. Geological Survey Miscellaneous Field Studies Map MF-2154-E, 2 figs., 2 sheets, scale 1:250,000.

_____1994, Principal facts and field data for gravity data in and adjacent to the Reno 1° x 2° quadrangle, Nevada and California: U.S. Geological Survey Open-File Report 94-006, Part A, documentation, 16 p.; Part B, digital gravity data, 3½-inch diskette.

Plouff, Donald, and Conradi, Arthur, Jr., 1975, Gravity data in Crump Geyser area, Oregon: National Technical Information Service, PB-245-426, 16 p.

Plouff, Donald, Robbins, S.L., and Holden, K.D.,1976, Principal facts for gravity observations in the Charles Sheldon Antelope Range, Nevada-Oregon: U.S. Geological Survey Open-File Report 76-601, 22 p.

Robbins, S.L., Oliver, H.W, and Sikora, R.F., 1976, Principal facts, accuracies, sources, base station descriptions and plots for 1794 gravity stations on the Susanville 1° by 2° quadrangle, California: National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161, PB-76-254061.

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.

Schaefer, D.H., Duffrin, B.G., and Plume, R.W., 1985, Principal facts for gravity stations in Paradise and Stagecoach Valleys, Humboldt and Lyon Counties, Nevada: U.S. Geological Survey Open-File Report 85-694, 15 p.

Schaefer, D.H., and Maurer, D.K., 1980, Principal facts for gravity stations in the western arm of the Black Rock Desert, Nevada: U.S. Geological Survey Open-File Report 80-577, 15 p.

Schaefer, D.H., Thomas, J.M., and Duffrin, B.G., 1984, Principal facts for gravity stations in Dixie, Fairview, and Stingaree Valleys, Churchill and Pershing Counties, Nevada: U.S. Geological Survey Open-File Report 84-586, 15 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.

Sikora, R.F., 1991, Principal facts for 133 gravity stations, with color maps of Bouguer and isostatic residual gravity anomalies on the Winnemucca 1° by 2° quadrangle, Nevada: U.S. Geological Survey Open-File Report 91-256, Part A, Principal facts documentation, 40 p.; Part B, Gravity data on diskette.

Snyder, D.B., Roberts, C.W., Saltus, R.W., and Sikora, R.F., 1982, Magnetic tape containing the principal facts of 64,026 gravity stations in the State of California: National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161, PB-82-168279, description, 30 p.; PB-82-168287, 9-track magnetic tape.

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

Trexler, D.T., Koenig, B.A., Flynn, Thomas, Bruce, J.L., and Ghusn, George, Jr., 1981, Low- to moderate-temperature geothermal resource assessment for Nevada: Area Specific Studies, Pumpernickel Valley, Carlin and Moana--Final Report, June 1,1980-August 30, 1981: U.S. Department of Energy, DOE/NV/10039-3, 202 p.

Trexler, D.T., Flynn, Thomas, Koenig, B.A., Bell, E.J., and Ghusn, George, Jr., 1982, Low- to moderate-temperature geothermal resource assessment for Nevada: Area Specific Studies, Pumpernickel Valley, Carlin and Moana--Final Report, June 1,1981-July 31, 1982: U.S. Department of Energy, DOE/NV/10220-1, 145 p.

Wagini, Alexander, 1985, Principal facts, accuracies, and sources for 1,951 gravity stations on the Winnemucca 1° by 2° quadrangle, Nevada: National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161, PB-85-235927, 74 p.

Wahl, R.R., and Peterson, D.L., 1976, Principal facts for gravity stations in the Carson Sink region, Nevada: U.S. Geological Survey Open-File Report 76-344, 17 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.

_____1979, The new gravity system--changes in international gravity base values and anomaly values, Geophysics, v. 44, no. 8, p. 1352-1366.

Woollard, G.P., and Rose, J.C., 1963, International gravity measurements: Tulsa, Oklahoma, Society of Exploration Geophysicists, 518 p.

**Table 1.--Description of files in diskette**

[Headings in bold print are directory names. Suffix .ISN, principal facts; suffix .FLD, raw field data. Number in parentheses indicates number of data points in file.]

---

README.-

**ALTURAS**

ALTXSV95.ISN (437)--from Snyder and others (1982)

DELETE.ALT (224)--redundant and doubtful data

GRISCOM.ISN (110)--from Griscom and Conradi (1976)

**BOUNDARY**

95BNDRY.PLF--points that delineate approximate boundary of WSRAA

95BNDRYU.OLN--points that delineate approximate boundary of WSRAA without Oregon stateline

GATHER.PLF--vertices of polygon that encloses all data points in study and adjacent area

MARGIN3.OLN--vertices of polygon that includes part of area to display contours

STATE500.NAM, STATESWH.NAM--locations of state names at scales of 1:500,000 and 1:2,000,000

STATESWH.OLN--geographic coordinates that delineate statelines

**FACTS80S**

BLM80S.ICE (1,020)--principal facts from Plouff (1987); most data points are accounted for in other directories.

**FIELD**

BALTAZOR.FLD--for study by Peterson and Hoover (1977; D.L. Peterson, written commun., 1977)

BLM84.BAS, BLM85.BAS, BLM86.BAS--observed gravity for base and repeat stations, 1984-1986

BLM84.FLD, BLM85.FLD, BLM86.FLD--collected 1984-1986 for study by Plouff (1987)

BLM938.FLD, BLM938.BAS-raw field data and observed gravity for base and repeat stations, 1993

G17.CAL, G17B.CAL, G192, G8B.CAL--calibration tables for gravity meters except for W177 at Baltazor

MCD7576.FLD--raw field data for studies by Plouff (1976, 1977)

SHELDON.FLD--raw field data for studyy Plouff and others (1976)

WARNER.FLD--raw field data for study by Plouff (1975)

**LOVELOCK**

BLACKLOV.ISN (210)--obtained by National Geophysical Data Center from Schaefer and Maurer (1980)

COGBLOV.ISN (282)--obtained by National Geophysical Data Center from study by Cogbill (1979)

CREWLOV.ISN (437)--obtained by National Geophysical Data Center from Crewdson (1976)

DELETE.LOV (630)--redundant and doubtful data

DMALOV.ISN (256)--from National Geophysical Data Center (1984)

GEOTHLOV.ISN (146)--from Peterson and Dansereau (1975) and Peterson and Kaufmann (1978a, b, c)

HOUSELOV.ISN (90)--from Duffrin and others (1985)

PASSCLOV.ISN (27)--from Glen and others (1987)

PLOUFLOV.ISN (164)--from Plouff (1987, 1994) and data collected in 1993

WAHLLOV.ISN (104)--from Wahl and Peterson (1976)

**MCD**

COGBMCD.ISN (80)--obtained by National Geophysical Data Center from study by Cogbill (1979)

DELETE.MCD (270)--redundant and doubtful data

DMAMCD.ISN (130)--from National Geophysical Data Center (1984)

OSGDMCD.ISN (63)--from Abrams and others (1984)

PLOUFMCD.ISN (265)--from Plouff (1977, 1987) and data collected in 1993

PV.ISN (80)--from Schaefer and others (1985)

SALTMCD.ISN (345)--from Saltus (1988) but not identified from National Geophysical Data Center (1991)

**MILLETT**

DELETE.MIL (78)--redundant and doubtful data

DMAMIL.ISN (50)--from National Geophysical Data Center (1984)

PASSCMIL.ISN (4)--from Glen and others (1987)

WRDMIL.ISN (52)--from Schaefer and others (1984)

**OREGON**

DELETE.ORE (51)--redundant and doubtful data from compilations after 1990

OREG95.ISN (271)--from Plouff (1977, 1987) and National Geophysical Data Center (1991)

**Table 1.--Description of files in diskette (continued)**

**RENO**
RENO95.ISN (619)--from Plouff (1994)
**SUSAN**
SUSAN95.ISN (63)--from Snyder and others (1982) and Plouff (1987)
**VYA**
ALTUR71.ISN (20)--from Griscom and Conradi (1976) and Snyder and others (1982)
BLACKVYA.ISN (119)--obtained by National Geophysical Data Center from Schaefer and Maurer (1980)
COGBVYA.ISN (68)--obtained by National Geophysical Data Center (1984) from study by Cogbill (1979)
DELETE.EDQ (99)--redundant and doubtful data in data set from study by Edquist (1981)
DELETE.VYA (239)--redundant and doubtful data
DMAVYA.ISN (149)--from National Geophysical Data Center (1984)
EDQUIST.ISN (92)-- obtained by National Geophysical Data Center (1991) from study by Edquist (1981)
GEOTHVYA.ISN (104)--from Peterson and Hassemer (1977), Peterson and Hoover (1977), and Peterson and Kaufmann (1978a)
PLOUFVYA.ISN (997)--from Plouff (1977, 1987) and data collected in 1993
**WINNE**
COGBWIN.ISN (1)--obtained by National Geophysical Data Center from study by Cogbill (1979)
DELETE.WIN (86)--redundant and doubtful data not listed by Wagini (1985)
PASSCWIN.ISN (1)--from Glen and others (1987)
PLOUFWIN.ISN (13)--from Plouff (1987) and data collected in 1993
SALTWIN.ISN (10)-- from Saltus (1988) but not identified in other sources
SIKORA.ISN (1,216)--from Wagini (1985) and not included in other files

**Table 2.--Data sources from National Geophysical Data Center (1991) in Nevada part of the WSRAA**

[First column is 4-digit source code. Second column indicates number of data points in the WSRAA. Descriptions were abbreviated from the National Geophysical Data Center (1991). CDMG, California Division of Mines and Geology; DMAHTC, Defense Mapping Agency, Topographic Command; GSS, Geodetic Survey Squadron; KGRA, Known Geothermal Resource Area; OFR, Open-File Report; UNV, University of Nevada; USGS, U.S. Geological Survey; UW, University of Wisconsin. Bold letters indicate abbreviations that are used for the 4-digit source code. Number in square brackets is number of data points retained. *, data discussed separately in report. Last number, if present, is correction added by the NGDC to the published value of observed gravity.]

| | | |
|---|---|---|
| 2179 | 432 | NEVADA BASIN AND RANGE PROJECT. USGS (D. Mabey). Date Unknown. **B, G.** [261] |
| 2235 | 113 | CARSON SINK, NEVADA. USGS (R. Wahl). Survey, 1963-1964. **S0, S1.** [*] -14.58 mGal |
| 2531 | 1 | OREGON STATE GRAVITY DATA. OREGON STATE UNIVERSITY. Survey, 1965. **O.** [0] |
| 2649 | 4 | J.I. GIMLETT. WARM SPRINGS VALLEY, WASHOE COUNTY, NEV. STANFORD, 1965. [4] |
| 2695 | 8 | GRAVITY DATA, NORTHERN NEVADA. USGS. Survey, 1958. [2] |
| 2713 | 1 | T.R. LAFEHR. SOUTHERN CASCADE RANGE, CALIFORNIA. USGS, 1965. **L.** [0] |
| 2773 | 5 | ALTURAS, CALIFORNIA AREA. USGS. Survey, 1967. **A.** [*] -14.45 mGal |
| 3046 | 45 | J.W. ERWIN. BATTLE MOUNTAIN AREA, NEV. UNV, MACKAY SCHOOL OF MINES. 1967. [38] |
| 3382 | 1 | CALIFORNIA GRAVITY FOR ALTURAS AMS SHEET. CDMG. Survey, 1970. [*] -14.25 mGal |
| 3507 | 8 | J. MACK and R.M. IVERSON. TRIP AI, SERIES M. UW. Survey, 1955. [0] |
| 3578 | 27 | W.E. BLACK. TRIP TW, SERIES F. UW. Survey, 1950. [0] |
| 3598 | 16 | N.A. OSTENSO. TRIP ZZ, SERIES NI. UW. Survey, 1953. [0] |
| 3682 | 1 | OREGON STATE GRAVITY BASE NETWORK. DMATC. Survey, 1971. [0] |
| 3891 | 325 | WINNEMUCCA SHEET. UNV, MACKAY SCHOOL OF MINES. Survey, 1972. [208] |
| 4078 | 3 | R.H. CHAPMAN, C. BISHOP. BOUGUER MAP OF CALIFORNIA. CDMG. 1964. **C.** [*] |
| 4099 | 20 | GRAVITY DATA IN THE UNITED STATES, NORTH-SOUTH PROFILES. DMATC. HAWAII INSTITUTE OF GEOPHYSICS (HIG). Survey, 1967. **W.** [1] |
| 4735 | 2 | R.H. CHAPMAN. ALTURAS AREA OF CALIFORNIA. CDMG. Date Unknown. [*] -14.58 mGal |

**Table 2.--National GeophysicalData Center (1991) data sources (continued)**

| | | |
|---|---|---|
| 4787 | 254 | SHELDON ANTELOPE RANGE NEV AND OREG. OF 76-601. USGS (Plouff). Survey, 1976. [*] -14.58 mGal |
| 4788 | 345 | MCDERMITT, NEVADA. OFR [76-599 and] 77-536. USGS (Plouff). Survey, [1975,] 1976. [*] -14.50 mGal |
| 4834 | 103 | D.L. PETERSON, D.A. DANSEREAU. GERLACH AND SAN EMIDIO KGRA's, NEVADA. OFR 75-0668. USGS. Survey, 1976. **G.** [73] -13.79 mGal |
| 4869 | 32 | D.L. PETERSON, D.B. HOOVER. BALTAZOR KGRA, NEVADA, OFR 77-67C. USGS. 1976. **G.** [17] -13.70 mGal |
| 4933 | 52 | D.L. PETERSON, J.H. HASSEMER. PINTO HOT SPRINGS KGRA, NEV., OFR 77-67B. USGS, 1977. [49] -13.70 mGal |
| 4999 | 489 | A.H. COGBILL. REGIONAL GRAVITY SURVEY WESTERN NEVADA. NORTHWESTERN UNIVERSITY. Survey, 1976. **CG.** [398] |
| 5018 | 48 | D.L. PETERSON, H. E. KAUFMANN. DOUBLE HOT SPRINGS KGRA, HUMBOLDT COUNTY, NEVADA. OFR 78-107A. USGS, 1977. [48] -13.79 mGal |
| 5019 | 51 | D.L. PETERSON, H.E. KAUFMANN. GERLACH EXTENSION KGRA, PERSHING COUNTY, NEVADA. OFR 78-107B. USGS. Survey, 1977. [39] -13.79 mGal |
| 5020 | 43 | D.L. PETERSON, H.E. KAUFMANN. FLY RANCH EXTENSION KGRA, PERSHING COUNTY, NEVADA. OFR 78-107C. USGS, 1977. [24] -13.79 mGal except two |
| 5069 | 153 | J.W. ERWIN. RENO, NEVADA GRAVITY SURVEY. UNV. Survey, 1978. **E.** [8] |
| 5116 | 139 | GRAVITY DATA, NEVADA. DMAHTC/GSS. Survey, 1968. **F, K.** [74] |
| 5130 | 124 | GRAVITY DATA FOR NEVADA. DMAHTC/GSS. Survey, 1969. **P, Q.** [69] |
| 5144 | 123 | GRAVITY DATA FOR THE STATE OF NEVADA. DMAHTC/GSS. Survey, 1971. **H.** [80] |
| 5163 | 188 | NEVADA REGIONAL GRAVITY SURVEY. DMAHTC/GSS. Survey, 1972. **V, X.** [136] |
| 5503 | 592 | R.A. CREWDSON. GEOPHYSICAL STUDIES IN THE BLACK ROCK DESERT GEOTHERMAL PROSPECT, NEVADA. COLORADO SCHOOL OF MINES. Survey, 1976. **RC.** [437] -12.73 mGal |
| 5675 | 16 | GRAVITY DATA IN NEVADA AND CALIFORNIA. USGS. Survey, 1980. **G.** [*] -14.58 mGal |
| 5869 | 458 | D.H. SCHAEFER and D.K. MAUER. PRINCIPAL FACTS FOR WESTERN ARM OF THE BLACK ROCK DESERT, NEVADA. OFR 80-0577. USGS, 1979. **B.** [329] -12.79 mGal |
| 5962 | 40 | D.H. SCHAEFER. BASIN AND RANGE IN NEVADA. USGS. Date Unknown. [31] |
| 6126 | 1 | J.W. ERWIN. WELLS ONE BY TWO DEGREE AREA IN NEVADA. NEVADA BUREAU OF MINES AND GEOLOGY, UNV. Survey, 1979. [0] |
| 6625 | 232 | R.K. EDQUIST. NEVADA, BALTAZOR HOT SPRINGS AND PAINTED HILLS. U.S. DEPARTMENT OF ENERGY. Survey, 1981. [92] -14.50 mGal |
| 6948 | 134 | C.K. MOSS and G.A. ABRAMS. OSGOOD MOUNTAINS, HUMBOLDT COUNTY, NEVADA. OFR 84-835. USGS, 1984. [96] 0.00 mGal |
| 6976 | 169 | B.G. DUFFRIN, D.L. BERGER, and D.H. SCHAEFER. HUMBOLDT HOUSE GEOTHERMAL AREA, PERSHING COUNTY, NEVADA. OFR 85-162. USGS, 1981. **HH.** [90] -28.55 mGal |
| 7358 | 567 | A. WAGINI. 1951 GRAVITY STATIONS ON THE WINNEMUCCA 1X2 DEGREE QUADRANGLE, NEVADA. USGS, 1985. [*] 0.00 mGal |
| 7567 | 178 | D.H. SCHAEFER, B.G. DUFFRIN, R.W. PLUME. PARADISE VALLEY, HUMBOLDT AND LYON COUNTIES, NEVADA. OFR 85-694. USGS, 1983. [80] -8.00 mGal |
| 7838 | 29 | J.M. GLEN, J.S. LEWIS, D.A. PONCE. PASSCAL SEISMIC LINE IN WEST-CENTRAL NEVADA. OFR 87-0403. USGS Survey, 1986. [28] 0.00 mGal |
| 7942 | 4 | R.R. WAHL D.L. PETERSON. CARSON SINK REGION NEV. OFR 76-0344. USGS. Survey, 1976. [*] -13.70 mGal |

**Table 3.--Explanation of four-digit accuracy code**

[Num, number of data points for which code was used in the WSRAA; USGS, U.S. Geological Survey. AG, accuracy in milligals; AM, accuracy in meters; BOE, accuracy of Bouguer gravity anomaly, in milligals, corresponding to elevation error, assuming 0.02 mGal/m; BOL, accuracy of Bouguer gravity anomaly in milligals corresponding to location error, assuming that all location error is along the north component of direction.]

| Code | Num | Explanation of location description code--first digit |
|---|---|---|
| B | 141 | On level-line bench mark or other permanent mark incorporated into USGS vertical control system, including National Geodetic Survey bench marks. |
| N | 987 | Near or possibly on level-line bench mark of USGS system. |
| V | 10 | On vertical-angle bench mark. |
| H | 85 | Near or possibly on vertical-angle bench mark. |
| D | 75 | Near assumed location of any of the above marks that was destroyed or not found. |
| P | 306 | Near surveyed elevation not printed on topographic map. |
| X | 208 | Near well-defined marks such as wells, windmills, microwave towers, or section corners. |
| F | 279 | Near location with or without a mark, at which a surveyed elevation is shown on a published map. |
| G | 1,082 | Near location (on a manuscript or published map) at which a spot elevation is determined by photogrammetry; near doubtful F-location. Printed in brown or with lettet "T" appended. |
| T | 4 | Elevation based on photogrammetry done by by USGS; or spot elevation not printed on published map. |
| K | 1 | Spot elevation based on photogrammetry determined by other organizations. |
| W | 7 | Edge of lake, canal, or reservoir; interpolated elevation or elevation given for water or dam at unknown height relative to present level. |
| A | 39 | Elevation determined by using altimetry with unknown accuracy. |
| C | 120 | Elevation determined by topographic contour interpolation. |
| Q | 31 | Elevation determined by topographic contour interpolation along drainages. |
| 2 | 240 | Along regularly spaced profile of stations; elevation source is unknown. |
| 3 | 164 | Near road or section line; elevation source is unknown. |
| U | 7 | Not near road or other landmark; elevation source is unknown. |
| (blank space) | | Code not assigned for 1,846 data points. |

| Code | Num | AM | BOE | Examples of elevation accuracy code--second digit |
|---|---|---|---|---|
| 1 | 225 | 0.05 | 0.01 | On or tied to level-line bench mark by surveying. |
| 2 | 183 | 0.15 | 0.03 | Elevation difference hand-leveled to nearby bench mark; elevation recorded to nearest foot. |
| 3 | 486 | 0.3 | 0.06 | Near bench mark. |
| 4 | 171 | 0.6 | 0.12 | On or near vertical-angle bench mark; flat area near level-line bench mark that was not found. |
| 5 | 758 | 1.5 | 0.3 | Near surveyed elevation on topographic map; elevation from map with 10-ft contour interval |
| 6 | 762 | 3.0 | 0.6 | Photogrammetric elevation or contour interpolation on map with 20-ft contour interval. |
| 7 | 276 | 6.0 | 1.2 | Uncertain location of photogrammetric spot elevation. |
| 8 | 31 | 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 | 8 | 30.0 | 6.0 | Location and elevation doubtful but no other data points nearby. |
| (blank space) | | | | Code not assigned for 2,732 data points. |

| Code | Num | AM | BOL | Examples of horizontal location code--third digit |
|---|---|---|---|---|
| 1 | 9 | 13 | 0.01 | Near vertical-angle bench mark. |
| 2 | 978 | 25 | 0.02 | Near permanent mark on map such as bench mark, section corner, or well. |
| 3 | 930 | 65 | 0.05 | Road intersection or stream fork. |
| 4 | 635 | 130 | 0.1 | Broad road curve or gentle hillcrest. |
| 5 | 242 | 250 | 0.2 | Location depends on odometer for interval greater than 1 mi, or other estimate. |
| 6 | 68 | 650 | 0.5 | Location consistent with elevation but located 0.5 mi from a definitive landmark. |
| 7 | 23 | 1,300 | 1.0 | No likely landmark within 1 mile. |
| 8 | 2 | 2,500 | 2.0 | Original location changed by 1 to 2 mi, to agree with location of the given elevation. |
| 9 | 10 | 5,000 | 5.0 | Doubtful location but no other data points nearby. |
| (blank space) | | | | Code not assigned for 2,735 data points. |

**Table 3.--Explanation of four-digit accuracy code (continued)**

| Code | Num | AG | Examples of codes for accuracy of observed gravity--fourth digit |
|---|---|---|---|
| 1 | 4 | 0.01 | Base station established with LaCoste and Romberg gravity meter. |
| 2 | 6 | 0.02 | Station established with multiple ties of high precision. |
| 3 | 151 | 0.05 | Repeated readings with LaCoste and Romberg gravity meter. |
| 4 | 1,801 | 0.1 | One reading with LaCoste and Romberg gravity meter. |
| 5 | 126 | 0.2 | Single tide-corrected reading with Worden gravity meter with good drift characteristics. |
| 6 | 577 | 0.5 | Value is average of two observations that are 1.0 mGal apart; uncertain datum shift. |
| 7 | 0 | 1.0 | Single reading of Worden gravity meter with doubtful drift characteristics. |
| 8 | 2 | 2.0 | Value is average of two observations that are 4 mGal apart. |
| 9 | 1 | 5.0 | Doubtful value. |
| (blank space) | | | Code not assigned for 2,964 data points. |

**Table 4.--Descriptions of base stations established by the Defense Mapping Agency (Jablonski, 1974)**

[Latitudes, longitudes, elevations in meters, values of observed gravity in milligals (IGSN-71 datum), values in milligals to be added to convert observed gravity to NGBN datum, and observers' descriptions of locations. CGS, bench mark established by the U.S. Coast and Geodetic Survey (National Geodetic Survey); E, N, S, and W, compass directions east, north, south, and west, respectively; Hwy, highway.]

| | | | | | |
|---|---|---|---|---|---|
| Alturas, California | 41° 29.02' | 120° 32.38' | 1330 m | 979,874.30 mGal | 13.72 mGal |
| "ACIC 1740-1" and "CH14." Probably destroyed. Main entrance to courthouse. On second step above groundlevel, 1.75 ft below CGS F-93 in W face of N balustrade. | | | | | |
| Denio, Nevada | 41° 59.70' | 118° 34.20' | 1285 m | 979,932.18 mGal | 13.76 mGal |
| "ACIC 2352-1." E side of main N-S Hwy. About 160 ft S of Oregon Stateline. 5 ft S of SE door to Post Office. On concrete porch. 1 ft NW of indentation of former marker. | | | | | |
| Fallon, Nevada | 39° 29.73' | 119° 45.38' | 1208 m | 979,730.77 mGal | 13.90 mGal |
| "ACIC 2351-1." About 1.5 mi N of Fallon at airport. NW corner of concrete porch at SW corner of southmost (administration) building. In 1993, epoxy remained from former metal disk. Elevation estimated from bench mark shown on topographic map at a distance of less than 200 m. | | | | | |
| Gerlach, Nevada | 40° 39.10' | 119° 21.17' | 1198 m | 979,815.37 mGal | 13.79 mGal |
| "ACIC 2350-1." About 150 ft SE of Hwy. 0.5 ft SE of S corner of railroad depot. 0.5 ft NE of SW edge of concrete apron. On epoxy remnants of removed marker. Ground vibration 0.02 mGal. | | | | | |
| Klamath Falls, Oregon | 42° 13.4' | 121° 46.9' | 1250 m | 979,981.91 mGal | 13.70 mGal |
| "ACIC 1300-2." NE end of first step to Main Street entrance to County Courthouse. 1.0 m below and 3.6 m NW of CGS K-74. | | | | | |
| Lovelock, Nevada | 40° 10.84' | 118° 28.54' | 1214 m | 979,779.08 mGal | 13.87 mGal |
| "ACIC 2348-1." 5 m S and 1.7 m E of E entrance to courthouse. On top step between last two pillars S. | | | | | |
| McDermitt, Nevada | 41° 59.91' | 117° 42.91' | 1350 m | 979,905.90 mGal | 13.78 mGal |
| "ACIC 2354-1." 0.1 mi E along stateline road from U.S. Hwy 95. On shaky concrete slab at SW corner of E porch at NE corner of gymnasium of High School. S of double doors. | | | | | |
| Reno, Nevada | 39° 32.38' | 119° 48.79' | 1390 m | 979,674.65 mGal | 13.75 mGal |
| "ACIC 0454-1." At campus of the University of Nevada in Reno. On concrete floor at corner in wall under stairway; inside and 1 m S of doorway below ground level at SE entrance to W wing of James G. Scrugham Building. Entrance is about 20 m NW of stairs leading down from parking lot. Elevation interpolated from topography may be lower. | | | | | |
| Winnemucca, Nevada | 40° 54.22' | 117° 48.22' | 1310 m | 979,810.48 mGal | 13.81 mGal |
| "ACIC 0474-1." About 4 mi W of Winnemucca. 3 ft W of door against wass of Air Service building at Municipal Airport. 3 ft E of phone booth. | | | | | |

Note for "List of new publications......."

Open-File Reports 96-290-A and 96-290-B. Principal facts and field observations for gravity data in and adjacent to the Bureau of Land Management's Winnemucca District and Surprise Resource Area, northwest Nevada and northeast California By Donald Plouff, 26 p.

Part A consists of a printed text, illustrations, and tables, which explain the organization of and the methods used to assemble 7,075 gravity data points needed to prepare a gravity map of an area of about 13.5 million acres administered by the Bureau of Land Management in northwest Nevada and northeast California. The discussion includes sources of gravity data, reduction methods, the quality of data, and suggested improvements.

Part B consists of one double-sided, double-density 3.5-inch diskette written with MS-DOS in ASCII format for personal computers. Requirements for Part B.--The diskette can be read by any IBM-compatible personal computer with a high-density diskette drive or by any Macintosh computer capable of reading DOS-formatted diskettes. The diskette contains a total of 967 kilobytes. A "README." file explains formats for 67 files of principal facts, field data, and geographic line data in 12 directories. Data points are located in Oregon (271) and the Alturas (547), Lovelock (1,716), McDermitt (963), Millett (106), Reno (619), Susanville (63), Vya (1,549), and Winnemucca (1,241) one- by two-degree quadrangles. Field data includes gravity meter readings, assumed repeat station values of observed gravity, and gravity meter calibration tables.