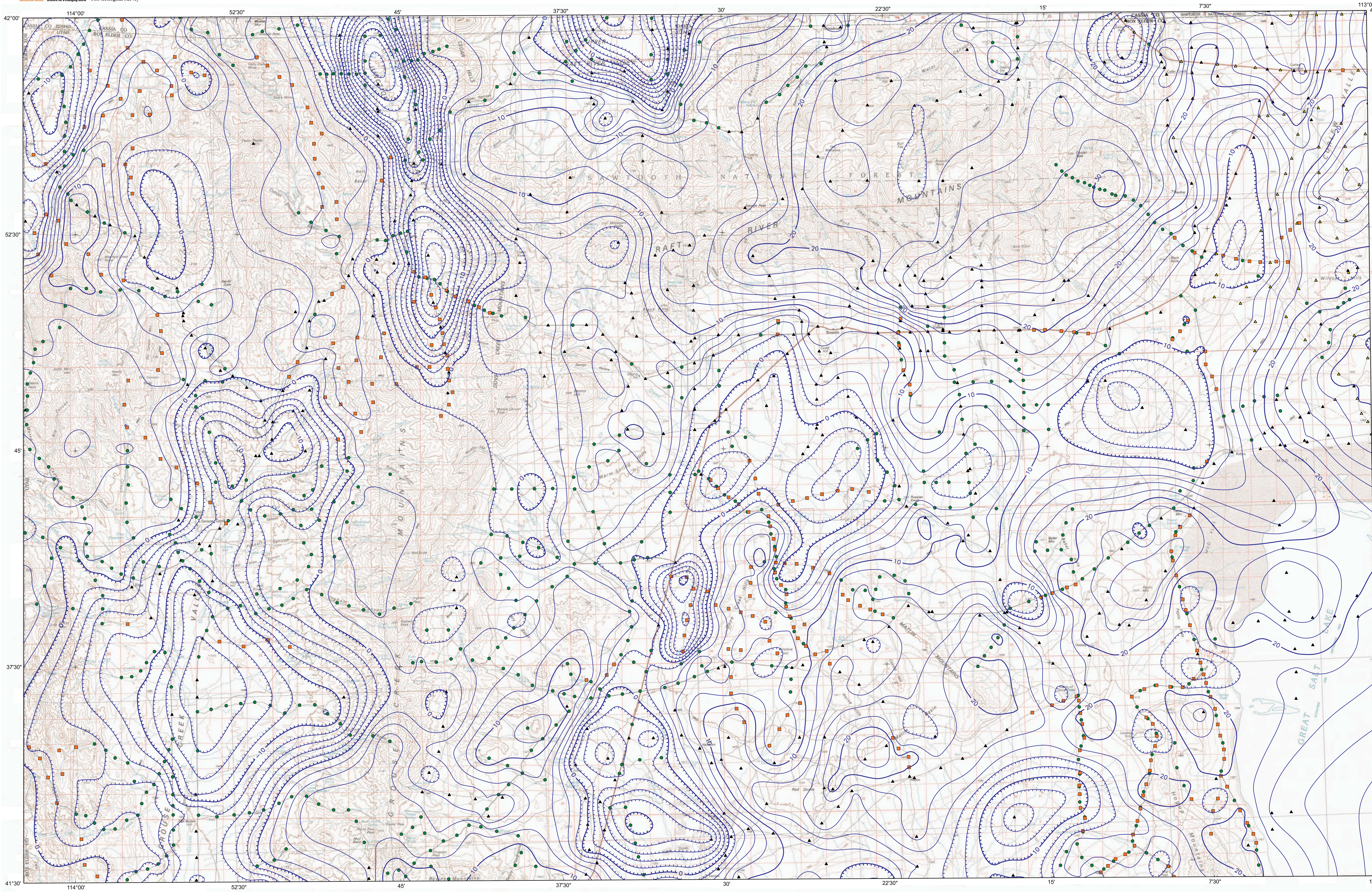
Utah Geological Survey
a division of
Utah Department of Natural Resources
in cooperation with
U.S. Department of the Interior
U.S. Geological Survey



Topographic base from U.S. Geological Survey 1:100,000 Grouse Creek and Jackpot quadrangles. Projection, Universal Transverse Mercator. 1927 North American Datum.

This map was funded by the Utah Geological Survey and the U.S. Geological Survey, National Cooperative Geologic Mapping Program. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied of the U.S. Government.

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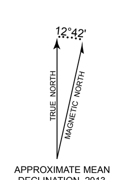
SCALE 1:100,000

2 0 2 4 6 Miles

2 0 2 4 6 Kilometers

Topographic contour interval 50 meters (Grouse Creek) and 40 meters (Jackpot)
Supplementary contour interval 10 m



PRELIMINARY ISOSTATIC GRAVITY MAP OF THE GROUSE CREEK AND EAST PART OF THE JACKPOT 30' x 60' QUADRANGLES, BOX ELDER COUNTY, UTAH, AND CASSIA COUNTY, IDAHO

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2013

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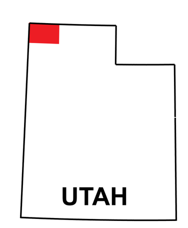
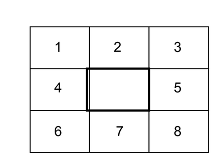


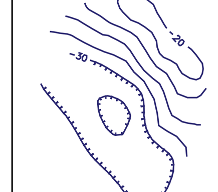
STUDY AREA



1. Rogerson
2. Oakley
3. Malad City
4. Jackpot
5. Tremonton
6. Wells
7. Newfoundland Mountains
8. Promontory Point

ADJOINING 30' X 60' QUADRANGLE NAMES

GRAVITY EXPLANATION



Gravity anomaly contours. Contour interval, 2 mGal. Hachures indicate gravity low.

STATION LOCATIONS

- ▲ Older data (Bankey and others, 1998)
- △ Utah Geological Survey (Hurlow and Burk, 2008)
- ■ Utah Geological Survey 2011-2012
- ● U.S. Geological Survey 2011-2012

ABSTRACT

This isostatic residual gravity map is part of an effort to map the three-dimensional distribution of rocks in northwest Utah. This map will serve as a basis for modeling the shape of basins and for determining the location and geometry of faults within the area. The map presents gravity anomalies contoured at an interval of 2 milliGals (mGal) on a topographic base at a scale of 1:100,000. Figure 1 shows contours with a color ramp applied to 2 mGal intervals, with artificial shading of the gravity field, at a scale of approximately 1:400,000. Local spatial variations in the Earth's gravity field, after accounting for variations caused by elevation, terrain, and deep crustal structure, reflect the distribution of densities in the mid- to upper crust. Densities often can be related to rock type, and abrupt spatial changes in density commonly mark lithologic or structural boundaries.

High-density basement rocks exposed within the Raft River and Grouse Creek Mountains include Archean and Proterozoic crystalline rocks overlain by metamorphic and sedimentary rocks that range from Proterozoic to Mesozoic in age. Alluvial sediments, usually located in the valleys, and Tertiary sedimentary rocks are characterized by low densities. However, with increasing depth of burial and age, the densities of these rocks may become indistinguishable from those of basement rocks. Tertiary volcanic rocks are characterized by a wide range of densities, but are less dense, on average, than the pre-Cenozoic basement rocks. Basalt within the quadrangle is as dense as crystalline basement, but is probably thin (less than 100 m thick; Miller and others, 2012).

Isostatic residual gravity values within the map area range from about –23 mGal over Junction Valley to about 32 mGal over the Raft River Mountains. Steep, linear gravity gradients coincide with the traces of several Neogene normal faults, most notably those bounding the southwest margin of the valley containing Goose Creek in the extreme northwest corner of the map. Gravity gradients also define concealed basin-bounding faults, such as those beneath Junction and Upper Raft River Valleys. These gradients result from juxtaposing dense basement rocks against thick Cenozoic sedimentary rocks.

DATA SOURCES, REDUCTIONS, AND ACCURACIES

The isostatic gravity map was created from 1447 gravity stations. Previously published data are from a regional compilation (Bankey and others, 1998). Other more recent sources include data collected in Curlew Valley for a hydrogeologic study (Hurlow and Burk, 2008), and efforts in 2011-2012 by the Utah and United States Geological Surveys. Gravity stations are non-uniformly distributed in the region. Station spacing is on average one station per 4 km^2, although the station spacing is as low as one station per 50 km^2 within remote parts of the quadrangle. Contours were computer-generated based on a 400-m grid using the principle of minimum curvature (Briggs, 1974). Although the data have been edited, caution should be exercised when interpreting anomalies controlled by only a single gravity station.

The datum of observed gravity for this map is the International Gravity Standardization Net of 1971 (IGSN 71) as described by Morelli (1974); the reference ellipsoid is the Geodetic Reference System of 1967 (GRS67; International Union of Geodesy and Geophysics, 1971). The observed gravity data were reduced to free-air anomalies using standard formulas (for example, Telford and others, 1990). Bouguer, curvature, and terrain adjustments to a radial distance of 166.7 km were applied to the free-air anomaly at each station to determine the complete Bouguer anomalies at a standard reduction density of 2670 kg/m^3 (Plouff, 1977). An isostatic adjustment was then applied to remove the long-wavelength effect of deep crustal and/or upper mantle masses that isostatically support regional topography. The isostatic adjustment assumes an Airy-Heiskanen model of isostatic compensation (Heiskanen and Vening-Meinesz, 1958). Compensation is achieved by varying the depth of the model crust-mantle interface, using the following parameters: a crustal thickness of 25 km for topography at sea level, a crust-mantle density contrast of 400 kg/m^3, and a crustal density of 2670 kg/m^3 for the topographic load. These parameters were used because (1) they were consistent with model parameters used for isostatic corrections computed for adjacent Nevada (Ponce, 1997), and (2) changing the model parameters did not significantly affect the resulting isostatic anomaly (Jachens and Griscom, 1985). The computer program ISOCOMP (Jachens and Roberts, 1981) directly calculates the attraction of an Airy-Heiskanen root by summing the attraction of individual mass prisms making up the root and thus calculating the isostatic adjustment. The resulting isostatic residual gravity values should reflect lateral variations of density within the mid- to upper crust. Higher gravity values in Curlew Valley and along the eastern part of the map may be caused by thick basalt flows (Hurlow and Burk, 2008), although equivalent values over Paleozoic limestone suggest that the highs may also be produced in part by deeper crustal density variations and/or crustal thinning in this area.

Accuracy of the data used to create this map is estimated to be on the order of ±0.1 to ±0.5 mGal based on comparison of observed gravity values at duplicate stations from different data sources and expected uncertainty resulting from the total terrain correction and station elevation. Note that some of the older data were located using a 1:250,000-scale quadrangle and plot parallel to roads. In a few cases where the elevation of the data point could be correlated to a benchmark elevation on a road, the data point was relocated and anomalies and terrain corrections recalculated. Total terrain corrections for the stations collected for this study ranged from 0.14 to 25.16 mGal, with an average of 1.51 mGal. If the uncertainty from the terrain correction is considered to be 5% to 10% of the terrain correction, the largest uncertainty expected for the data is 2.5 mGal. However, the likely uncertainty due to the terrain correction is small (less than 0.35 mGal) for most of the stations. The elevations are known to ±1 m or better for most of the measurements, yielding an uncertainty due to elevation in the anomaly value of <0.2 mGal.

ACKNOWLEDGMENTS

We thank Darcy McPhee, Dan Scheirer, Don Clark, Grant Willis, and Mike Sawlan for their reviews of the map. We thank various landowners for granting access. The study was supported by U.S. Geological Survey National Cooperative Geologic Mapping Program and the Utah Geological Survey.

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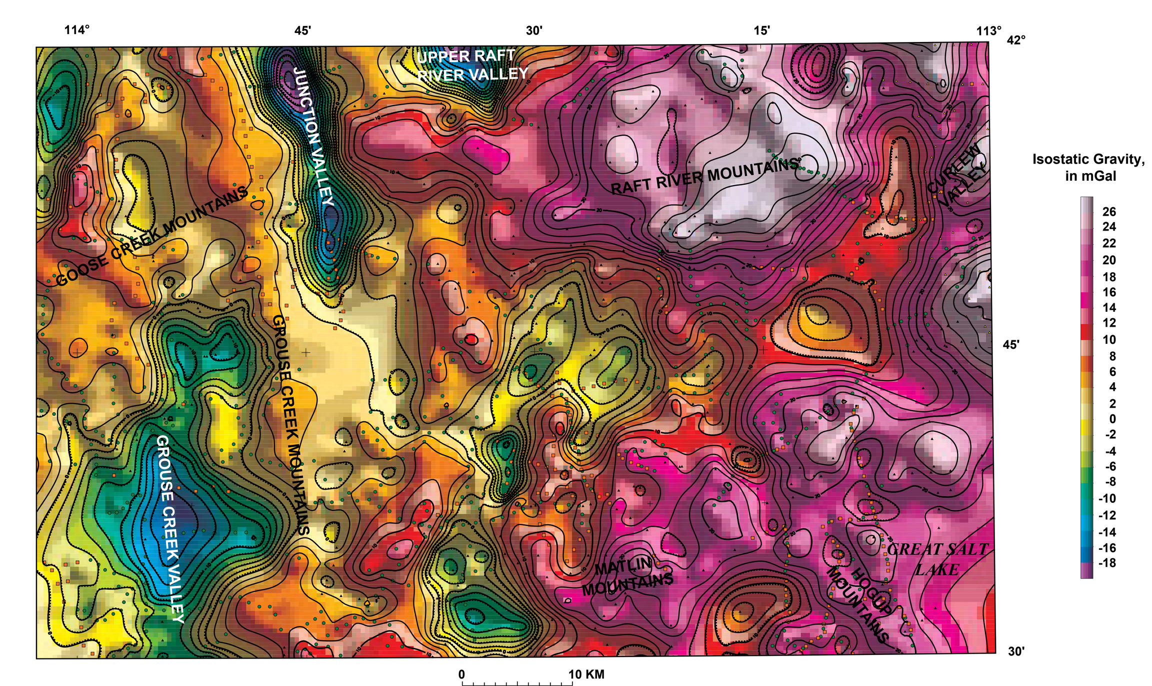

Figure 1. Color-shaded isostatic gravity map. Symbols are gravity measurements shown with same shape and color as on main map, but smaller.

Preliminary Isostatic Gravity Map of the Grouse Creek and East Part of the Jackpot 30´ x 60´ Quadrangles, Box Elder County, Utah, and Cassia County, Idaho

by V.E. Langenheim, H. Willis, N.D. Athens, B.A. Chuchel, S.M. Kraushaar, N.E. Knepprath, J. Rosario, J. Roza, A.I. Hiscock, and C.L. Hardwick

2013

Utah Geological Survey Miscellaneous Publication 13-2

ABSTRACT

A new isostatic residual gravity map of the northwest corner of Utah is based on compilation of preexisting data and new data collected by the Utah and United States Geological Surveys. Pronounced gravity lows occur over Junction, Grouse Creek, and upper Raft River Valleys, indicating significant thickness of low-density Tertiary sedimentary rocks and deposits. Gravity highs coincide with exposures of dense pre-Cenozoic rocks in the Raft River Mountains. Higher values in the eastern part of the map may be produced in part by deeper crustal density variations or crustal thinning. Steep linear gravity gradients coincide with mapped Neogene normal faults near Goose Creek and may define basin-bounding faults concealed beneath Junction and Upper Raft River Valleys.

CITATION

Langenheim, V.E., Willis, H., Athens, N.D., Chuchel, B.A., Kraushaar, S.M., Knepprath, N.E., Rosario, J., Roza, J., Hiscock, A.I., and Hardwick, C.L., 2013, Preliminary isostatic gravity map of the Grouse Creek and east part of the Jackpot 30´ x 60´ quadrangles, Box Elder County, Utah, and Cassia County, Idaho: Utah Geological Survey Miscellaneous Publication 13-2, 1 plate, scale 1:100,000.

NOTICES

This map was funded by the Utah Geological Survey and the U.S. Geological Survey, National Cooperative Geologic Mapping Program. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

GRAVITY DATA CONTENTS

The four data files included in Utah Geological Survey Miscellaneous Publication 13-2 are given as ascii data files and as Excel files on this CD, and are online at geology.utah.gov/maps/geophysmap/index.htm.

File old-gc-iso2.xls contains previously collected data from Bankey and others (1998). File curlew-gc-iso.xls contains data from Hurlow and Burk (2008). Files ugs-gc-iso.xls and usgs-gc-iso.xls contain data collected in 2011–2012 by the Utah Geological Survey and U.S. Geological Survey, respectively.

The format of the data files are described below.

The horizontal and vertical locations for the stations are on the North American Datum 1927 (NAD27) and the North American Vertical Datum 1929 (NAVD29), respectively.

The gravity stations (iso.xls) were referenced to the International Gravity Standardization Net 1971 (IGSN71) datum and the reference ellipsoid is the Geodetic Reference System 1967 (GRS67). The free-air anomalies were calculated using a modified version of formulas from Swick (1942). The complete Bouguer anomalies were calculated from the free-air anomalies using the Bouguer correction, terrain corrections, a curvature correction, and a reduction density of 2670 kg/m3 (2.67 g/cc). Isostatic corrections were calculated using an Airy-Heiskanen model of isostatic compensation. The depth of the crust-mantle boundary was controlled using the following parameters: a crustal thickness at sea level of 25 km, a density contrast of 400 kg/m3 (0.40 g/cc) between the crust and mantle, and a crustal density of 2670 kg/m3 (2.67 g/cc).

EXPLANATION OF PRINCIPAL FACT FORMAT FOR GRAVITY STATIONS

(old-gc-iso2.xls, curlew-gc-iso.xls, ugs-gc-iso.xls, and usgs-gc-iso.xls)

Fixed format. Format is as follows:

STATION NAME: An alphanumeric combination of up to 8 characters used for station identification. Columns 0–8

LATD: Degree latitude. Columns 9–11

LATM: Minute latitude. Columns 12–17

LOND: Degree longitude. Columns 18–21

LONM: Minute latitude. Columns 22–27

ELEV: Elevation. Columns 28–35

OG: Observed gravity. Columns 36–45

FAA: Free-air anomaly. Columns 52–58

SBA: Simple Bouguer anomaly. Columns 59–66

ITC: Inner terrain correction out to a radius of various distances (see TC CODE) from the station, for a density of 2.67 g/cc. Columns 67–73

TC: Total terrain correction from the station to 166.7 km for a density of 2670 kg/m3 (2.67 g/cc). Columns 74–80

TC CODE: Letter denoting the extent of the inner-zone correction, according to the Hayford-Bowie and Hammer templates (f=895 meters; M=2000 meters). Note in old-gc-iso2.xls data that have tc codes of M have had their locations or elevations adjusted. See Spielman and Ponce (1984) for additional explanation. Column 82

CBA: Complete Bouguer anomaly reduced for a density of 2670 kg/m3 (2.67 g/cc). Columns 83–90

ISO: Isostatic residual anomaly values. Columns 91–98.

Example of format for gravity file

```
36030032 41 52.60 113  8.08  4804.8 979887.32        2.09 -161.78   0.03   0.77 f -162.40   12.69
```

STATION NAME: 36030032

LATD: 41 degrees North

LATM: 52.60 minutes

LOND: 113 degrees West

LONM: 8.08 minutes

ELEV: 4804.8 feet

OG: 979887.32 mGal

FAA: 2.09 mGal

SBA: -161.78 mGal

ITC: 0.03 mGal

TC: 0.77 mGal

TC_CODE: f (895 m)

CBA: -162.40 mGal

ISO: 12.69 mGal

REFERENCES

Bankey, V., Grauch, V.J.S., and Kucks, R.P., 1998, Utah aeromagnetic and gravity maps and data—A web site for distribution of data (on-line version): U.S. Geological Survey Open-File Report 98-0761, http://greenwood.cr.usgs.gov/pub/open-file-reports/ofr-98-0761/utah.html.

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