DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE UTAH DEPARTMENT OF NATURAL RESOURCES
AND THE IDAHO DEPARTMENT OF WATER ADMINISTRATION

MISCELLANEOUS FIELD STUDIES
MAP MF-627

EXPLANATION

Cenozoic sediments

Cenozoic volcanics

Pre-Cenozoic bedrock

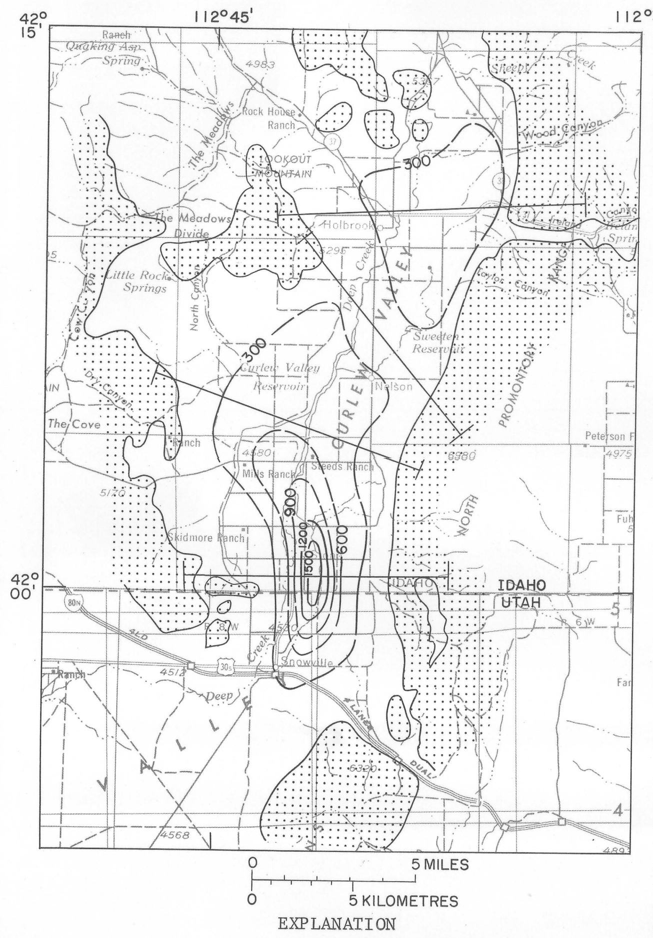
—150— Bouguer gravity—In milligals. Hachured to indicate closed areas of lower gravity

• Gravity station

Location of gravity survey

Geology modified from Stokes (1963) and from C. P. Ross and J. D. Forrester, 1947, Geologic map of the State of Idaho, U.S. Geol. Survey and Idaho Bur. Mines and Geology.

Base from U.S. Geological Survey Pocatello, 1954-62; Preston, 1955-61, Brigham City, 1954-70; Ogden, 1954-66.



EXPLANATION

Cenozoic sediments

Cenozoic volcanics and pre-Cenozoic bedrock

—300— Isopach of Cenozoic fill In metres

Gravity profile used to prepare this map Assumed density contrast is 0.5 g/cm³

Approximate thickness of Cenozoic fill in the northeastern part of Curlew Valley

BOUGUER GRAVITY

A gravity survey was made of parts of Box Elder, Davis, and Weber Counties, Utah, and parts of Cassia and Oneida Counties, Idaho, in 1970-71 as part of an investigation of the ground-water resources of the area. The purpose of the survey was to determine the gross thickness of low-density Cenozoic rock filling the valleys and the configuration of the underlying pre-Cenozoic bedrock. The area of this report is bounded by gravity surveys, on the west by Cook, Halverson, Stepp, and Berg (1964), on the north by Mabey and Wilson (1973), on the east by Peterson and Oriel (1970), on the south by Cook and Berg (1961), and on the southeast by Stewart (1958). Gravity data by Mabey, found in Feth, Barker, Moore, Brown, and Viers (1966), are included in the southeastern part of the area. Data by Cook, Halverson, Stepp, and Berg (1964) are included in the Curlew Valley area.

The area lies in the northeastern part of the Basin and Range province. The topography of the area is dominated by north-trending ranges and valleys. Altitudes range from more than 3,000 m in the Wasatch Range to about 1,300 m along the edge of the Great Salt Lake.

The following brief description of the rocks of the area is taken from Stokes (1963). Rocks of late Precambrian age crop out in the Raft River Mountains, Wasatch Range, and Promontory Mountains, and at Little Mountain (west of Ogden). (U.S. Geological Survey topographic maps show two mountains designated as Little Mountain, one west of Ogden and the other west of Bear River City; for clarity in reading the text the location of the Little Mountain under discussion is given.) These rocks consist mainly of quartzite, schist, dolomite, and other metamorphosed sediments. The remaining highlands consist mainly of limestone, dolomite, sandstone, quartzite, and shale which range in age from Early Cambrian to Early Permian.

Cenozoic rocks exposed within the valleys and basins consist mainly of poorly indurated to unconsolidated sand, silt, clay, conglomerate, marlstone, and volcanic rock. Flows of basalt and basaltic andesite occur near Rozel Point, at the northern end of Hansel Valley, in the vicinity of Cedar Hill and Kelton, and in the Wildcat Hills.

GRAVITY SURVEY

About 785 gravity stations were established in an area of 9,250 km². Observed gravity values were referred to base station WU29 in Salt Lake City, Utah (Behrendt and Woollard, 1961). Bouguer anomaly values were computed using an assumed density of 2.67 g/cm³ for the material above sea level. Most of the gravity stations were located at bench marks and at other points of known elevation. Elevations for a few stations in the northeastern part of Curlew Valley were determined by altimeter surveys. Terrain corrections were made through zone K of the Coast and Geodetic Survey system (Swick, 1942) for stations within or near the mountains. The accuracy of the gravity data is estimated to be about 2 mgal.

The survey area is at the north end of the Lake Bonneville basin, which is a major regional topographic depression. Bouguer gravity values are high over the basin and decrease toward the adjoining highlands (Mabey, 1960a). This regional variation is apparent on the gravity map, with the highest values near the shores of Great Salt Lake and generally lower values toward the higher areas to the north and east. This correlation between gravity and topography indicates isostatic compensation for the regional topography.

The largest density contrast is between the Cenozoic rocks and the more dense older rocks; however, significant density variations occur within these two groupings. The density of the pre-Cenozoic rocks generally increases with age, with the Precambrian metamorphic rocks being the most dense major unit in the region. Within the Cenozoic rocks, sedimentary units are normally less dense than the volcanic units, and well-sorted lacustrine sediments in the central parts of the valleys are less dense than the poorly sorted and generally more coarse material along the margins of the valleys.

The largest local gravity anomalies are the lows produced by the low-density sediments of Cenozoic age in the downfaulted valley blocks. In the interpretation of these anomalies, a single density contrast of 0.5 g/cm³ was assumed between these rocks and the more dense enclosing rocks. Models prepared using this single density contrast will generally indicate that the edge of each major valley is displaced toward the center of the valley because of lateral density contrasts within the fill (Mabey, 1960b; Pakiser and others, 1964).

A gravity trough, the northward extension of a feature to the south which is described by Cook and Berg (1961), is located along the western front of the Wasatch Range, Wellsville Mountains, and Malad Range. The gravity trough is interpreted as being produced by a thick accumulation of Cenozoic rocks with local areas of low closure which probably reflect deeper depressions along the trough.

Mabey (Feth and others, 1966) reported that the closed gravity low west of Ogden probably contains a thickness of Cenozoic rock on the order of 1,800-2,700 m.

About 32 km north of Ogden, a model was constructed along profile *A-A'*, from the Wellsville Mountains to the southern end of the Blue Springs Hills. The model shows about 2,100 m of Cenozoic rock filling the trough west of Brigham City and having a steeply dipping eastern edge.

The gravity trough diminishes in amplitude northward. Two prominent gravity saddles occur along the trough; one between Fielding and Plymouth, and the other about 6 km north of the Idaho-Utah State line. These saddles probably reflect a thinning of Cenozoic rock over structural highs of pre-Cenozoic bedrock. At the saddle between Fielding and Plymouth, the gravity anomaly and topography are offset left laterally. An east-trending fault in the southern end of the Malad Range near the gravity saddle is shown by Stokes (1963) and may be related to the offset.

A narrow gravity low, with about 20 mgal of closure, is located between the two gravity saddles. The model along profile *B-B'* shows a trough filled with about 1,500 m of Cenozoic rock and probably bounded by faults.

North of the Idaho-Utah State line the gravity trough widens over Malad Valley. The gravity low over the valley has more than 20 mgal of closure. A model along profile *C-C'* shows a structural depression bounded on the east by a major fault zone and on the west by an east-dipping floor. The model shows about 1,800 m of Cenozoic rock filling the valley.

A poorly defined, north-trending gravity high is located 24 km west of Ogden and is interpreted as reflecting a buried bedrock ridge. Little Mountain (west of Ogden) is located on the crest of the gravity high and is probably a part of the ridge. Values on the gravity high reach -140 mgal and are the highest in the eastern part of the area. The inferred ridge is believed to consist mainly of dense Precambrian rock because of the higher gravity values and because the rocks comprising Little Mountain are of Precambrian age. West of Brigham City this high is separated from a similar high over Little Mountain (west of Bear River City) by a northwest-trending gravity low. Little Mountain (west of Bear River City) may be an offset part of the inferred ridge, although Precambrian rock does not crop out on the mountain. Exposed rocks at Little Mountain (west of Bear River City) are chiefly quartzite, limestone, and dolomite of Middle Devonian to Late Mississippian age. Along profile *A-A'*, gravity values southeast and northwest of Little Mountain (west of Bear River City), near pre-Cenozoic rock, are much lower than over the mountain, and, therefore, it was necessary to assume a nonlinear, regional gravity gradient in order to model the thickness of low density Cenozoic rock along the profile. This suggests that Precambrian rock probably underlies the mountain at shallow depths.

A northwest-trending gravity low is located on the north side of Little Mountain (west of Bear River City) and is similar to the low on the south side of the mountain. These two lows reflect a thickening of Cenozoic rock, but may also reflect northwest structural trends.

Sparse gravity data west of Little Mountain (west of Bear River City) indicate a gravity low that probably reflects the northern end of a structural depression. The model along profile *A-A'* shows 1,800 m of Cenozoic rock in the depression. The steeply dipping eastern edge of the gravity low suggest a fault zone.

A gravity high suggests that the fill is thin. This high coincides with the Promontory Mountains and continues northeastward from Promontory for about another 8 km over valley fill and outcrops of Paleozoic sedimentary rock. The high is separated from the southeastern edge of Blue Creek Valley by a steep northwest-dipping gravity gradient, which is interpreted to reflect a fault zone.

A gravity low coincides with Blue Creek Valley and reflects a trough filled with low-density Cenozoic rock. The data indicate that the greatest thickness of Cenozoic rock occurs about 3 km southwest of Howell. The low over Blue Creek Valley is separated from a low over Pocatello Valley by a gravity saddle which reflects a bedrock high. Little gravity relief over Pocatello Valley suggests that there is no great thickness of Cenozoic rock filling the valley. The northeastern part of a gravity low is indicated near Rozel Point and two areas of lower gravity are located along the northwestern edge of Hansel Valley. These areas probably reflect a thickening of low-density Cenozoic rock. The gravity field is relatively high over the remainder of Hansel Valley suggesting that Cenozoic rock is thin or may consist, in large part, of more dense volcanic rock. Basalt and basaltic andesite crop out in the northern and southern parts of the valley.

A broad gravity high is centered over Curlew Valley with the peak of the high about 9 km southwest of Cedar Hill. Cook, Halverson, Stepp, and Berg (1964) suggested that the high may coincide with a possible doming of pre-Cenozoic sedimentary rock, which crops out at several locations along the eastern edge of the high and at one location about 5 km south of the Wildcat Hills on the western edge of the high. Cook, Halverson, Stepp, and Berg (1964) concluded that additional geologic or geophysical investigation is needed to better understand the source of the high; the author is in agreement with this conclusion.

The gravity data do not provide evidence of any major structural depressions filled with low-density Cenozoic rock in the vicinity of the Curlew Valley gravity high. If such depressions exist, they must be filled mainly with relatively dense volcanic rock, or be masked by the gravity high.

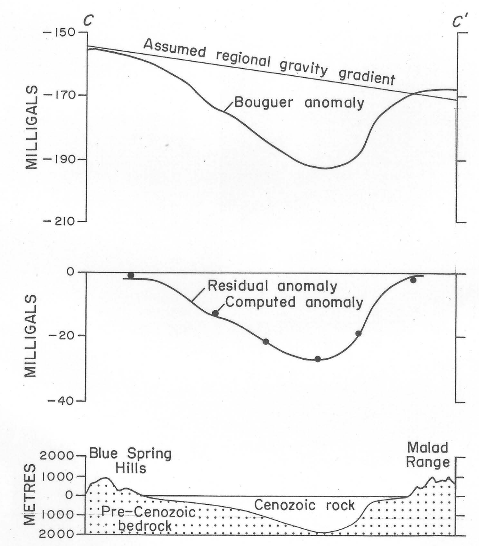
A north-trending gravity low is located in the northwestern part of Curlew Valley in the vicinity of Black Pine. Cook, Halverson, Stepp, and Berg (1964) suggested that the low probably reflects a grabenlike structure filled with 1,800 m or less of Cenozoic rock.

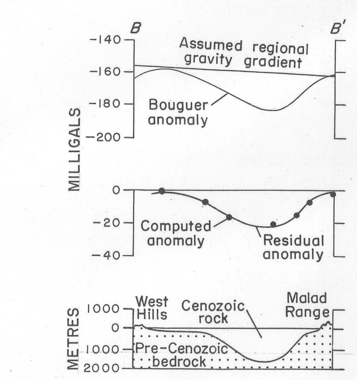
About 18 km to the east, another north-trending gravity low is located in the northeastern part of Curlew Valley. The valley is probably a structural depression, although data are too few along much of the valley edges to reveal faulting. South of Holbrook a gravity high suggests a buried bedrock ridge, dividing the valley into two subsurface basins. A map (inset) showing the thickness of low-density Cenozoic rock in the valley was prepared from 4 gravity profiles. The map shows more than 300 m of Cenozoic rock filling the upper basin and 300-600 m filling the northern half of the lower basin. In the southern half of the lower basin, the model reveals a deep, narrow depression filled with about 1,500 m of Cenozoic rock if a density contrast of 0.5 g/cm³ is assumed.

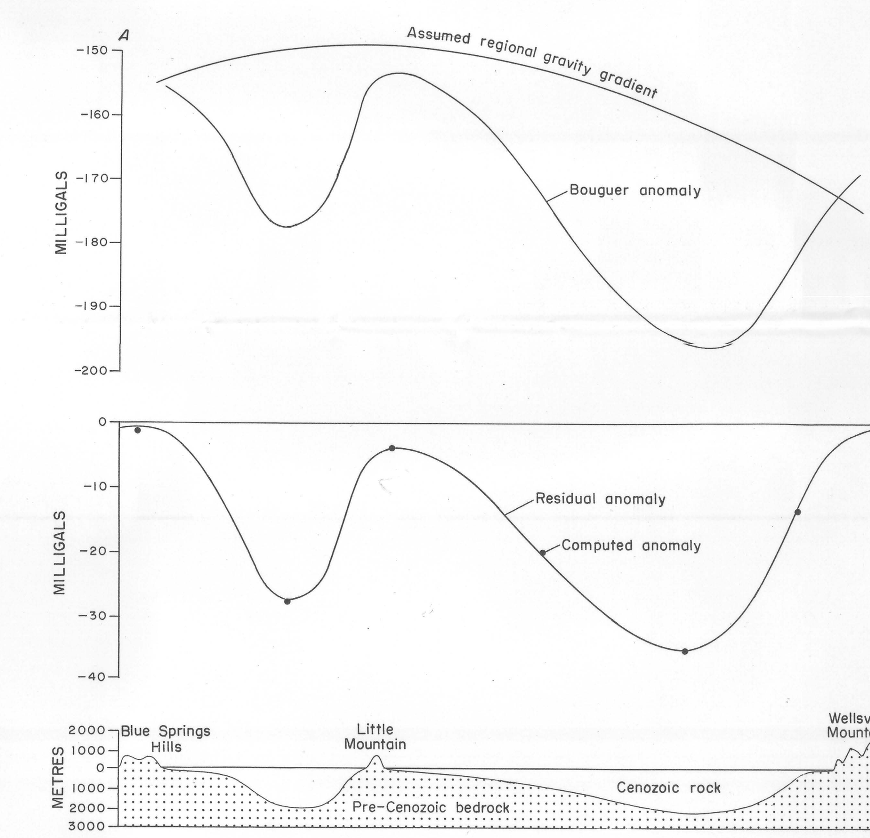
A small circular gravity high on the north side of the Wildcat Hills probably reflects pre-Cenozoic rock at a shallow depth. A drill hole about 6.5 km northeast of the high penetrated pre-Cenozoic rock at a depth of 134 m (Peace, 1956).

A gravity low is indicated by the eastward nosing of the -150 mgal contour over the Wildcat Hills. The low probably reflects the low-density volcanic rock comprising much of the hills.

A north-trending gravity low is located in the western part of Curlew Valley between the Raft River Mountains and Wildcat Hills. The low has been mapped southwestward for about another 50 km by Cook, Halverson, Stepp, and Berg (1964). Khattab (1969) suggested that the gravity low may reflect a narrow, crustal depression or foredeep, bordering an area of overthrusting to the west that moved a thick plate of Paleozoic rock in an easterly direction in mid-Mesozoic time. The gravity low could also be produced by a prism of Cenozoic rock.







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SCALE 1:250 000
5 0 5 10 MILES
5 0 5 10 KILOMETRES

BOUGUER GRAVITY MAP OF PART OF THE NORTHERN LAKE BONNEVILLE BASIN, UTAH AND IDAHO

By
Donald L. Peterson
1974

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