(200)
R290
no.415

U.S. Geological Survey
Reports. Open file series, no. 415.

A REGIONAL GRAVITY SURVEY OF THE CUYUNA IRON RANGE, MINNESOTA

By

GEORGE AUSTIN DURFEE

U. S. GEOLOGICAL SURVEY
DENVER
JUN 24 1957
LIBRARY

This map is preliminary
and has not been edited
or reviewed for conformity
to Geological Survey
standards and nomenclature.

U. S. GEOLOGICAL SURVEY

Released to open files
JUN 10 1957

57-41

38526

Contents

	Page No.
Abstract	3
Introduction	4
Physiography	6
Geology	7
Instrumentation	10
Gravity	10
Elevations	10
Field Procedure	12
Reduction of Data	14
Gravity	14
Drift Correction	
Elevation Correction	
Latitude Correction	
Terrain Correction	
Reduction of Gravity to Absolute Values	
Elevations	16
Interpretation of Gravity Data	18
Interpretation of Magnetic Data	23
Conclusions	25
References	26
Appendix	27
Bouguer Gravity Map of the Cuyuna Iron Range, Minnesota	back cover

Abstract

A regional gravity survey of the Cuyuna Iron Range, Minnesota, was conducted during the summer of 1955 by the U. S. Geological Survey. It was believed that gravity data would aid in the understanding of the major structures of the range.

It was found that synclinal and steeply dipping structures produced positive gravity anomalies while anticlinal structures produced negative anomalies. This principle was noted in areas of well known geology and then applied to outlying areas of the district. The outstanding gravity feature is a narrow positive anomaly extending from south of Brainerd eastward through Aitkin, the axis of the anomaly being somewhat south of the South Range. This gives support to the theory that the Biwabik formation passes under the stratigraphically higher South Range member as a synclinal structure. However, this anomaly is also explained using one main iron formation and assuming an anticlinal structure between the North and South Ranges and a syncline between the South Range and Bay Lake. A large magnitude negative gravity anomaly north of Mille Lacs is postulated to result from an intrusive mass extending to the erosion surface. Aero-magnetics are used to strengthen the gravity interpretation.

The need is realized for additional regional gravity coverage to the east of the area included in this survey and a detailed gravity study of the area between the North and South Ranges.

Introduction

The object of this paper is to attempt to interpret the major geological structures of the Cuyuna Range, with emphasis on the area between the North Range and Mille Lacs Lake, by gravimetric means.

The field work, conducted during the summer of 1955, was under the direction of the U. S. Geological Survey. During the past several years the Survey has done considerable magnetic work, both air and ground, on the Cuyuna Range; and it was felt that gravity data would aid in its interpretation.

The gravity work, because of time limitations, was confined to the portion of the Cuyuna Range covered by the following U.S. Geological Survey 15' quadrangles: Brainerd, Deerwood, Wealthwood, Aitkin, and Cuyuna. Traverses were also made in the vicinity of Dam Lake, 10 miles east of Aitkin, and to the Jenkins area, 25 miles northwest of Crosby. The latter two traverses provided insufficient coverage to give a good picture of the major gravity trends and were not used in contouring the area.

Several mining companies on the Cuyuna Range have made use of detailed, local, gravity surveys to aid in the location of ore bodies, although no results of these projects have been made public. During the summer of 1955 Budd Adams of the University of Wisconsin conducted a regional gravity survey of an area comprising most of northeast Minnesota including a portion of the Cuyuna Range. Edward Theil, also of the University of Wisconsin, completed a gravity survey extending from the Bayfield Peninsula of Wisconsin to southwest Minnesota and Iowa. This work did not include the Cuyuna Range but did traverse a portion of the Lake Superior geosyncline.

Previous geophysical work on the Cuyuna Range has been confined mainly to magnetic prospecting. Iron ore was first located in this area in 1903 when Cuyler Adams drilled an area of maximum magnetic attraction near Deerwood. Iron formations had been indicated in the 1850's by compass deflections. Aerial magnetic surveys have proved useful in tracing the major features. In 1955 the Geological Survey reflew the region at an altitude of 500 feet and with a line spacing of one quarter mile. When available, these maps should provide much detailed information. Experimental mapping, using resistivity and electromagnetic methods, has proved interesting and may warrant further work.

Gravity measurements on a regional scale seem very useful in interpreting the major structures although much more work is needed in the determination of formation densities. Many facies changes in the iron formation will make this a difficult task. Detailed surveys of high accuracy have proved useful in economic applications.

Physiography

The Cuyuna Iron Range is located in north central Minnesota extending some 65 miles northeasterly from Todd County, through Morrison and Crow Wing Counties, to central Aitkin County. The width of the band of iron formation varies, because of folding, from two to 12 miles. The majority of present mining activity is concentrated in the vicinity of Crosby and Ironton. The Cuyuna ore is generally transported by rail to Duluth, 100 miles to the east, for shipment to lower lake ports.

Topographically the Cuyuna Range is rather flat with maximum relief of 200 feet. A glacial moraine forms a series of hills northwest of Brainerd and, as the ice retreated to the northeast, glacial waters formed a series of smaller gravel ridges which stand above the flat, swampy, outwash plains. Studies of the glacial deposits by Zumberger (1952) indicates several advances of the ice. Although the Mississippi River closely parallels the range, drainage in the area is very incomplete. The outcrops and the topographic ranges characteristic of the other Lake Superior iron mining districts are lacking in the Cuyuna.

Mining and agriculture are the important industries of the district. The numerous lakes also make it a popular resort area. Logging operations have removed most of the heavy timber, leaving second growth hard and soft woods. The climate is temperate with warm summers and moderate to severe winters. The July mean temperature is 68 degrees, while the January mean is six degrees. Precipitation averages about 30 inches. Mining operations are halted during the winter months.

Geology

This brief discussion of the geology of the Cuyuna Range is summarized from Grout and Wolff (1955). This is the most recent and comprehensive publication covering the geology of the area.

The Cuyuna Range is believed to be a complex drag fold on the northwest limb of the Lake Superior geosyncline, the axis of the syncline being marked by intrusives south of Mille Lacs. The geologic section of east central Minnesota is as follows:

- Pleistocene
  - Recent alluvium
  - Wisconsin till and outwash
  - Pre-Wisconsin till and outwash
- Cretaceous
  - Sands, clays, and conglomerates, with fossils
- Cambrian
  - Upper Cambrian sandstone
- Precambrian
  - Later
    - Keweenawan
      - Thick sandstone
      - Flows, intrusives, gabbros, and granites
      - Thin sandstone
    - Animikie
      - Igneous flows (?), sills, and dikes
      - Virginia formation, argillite and slate
        - Upper slates
        - South Range iron-bearing member
        - Lower slates
      - Biwabik iron formation
      - Pokegama formation, quartzite and slate
  - Medial
    - Algoman granite
    - Thomson formation
      - Slates and graywackes
      - Local dolomites

Earlier

Granites and gneisses
Greenstones, schists

The geology of the Cuyuna Range must be studied from drill cores and exposures in open pit mines as there are no natural rock outcrops in the area. Correlation within the Cuyuna district is difficult because of rather complex structure and facies changes within the formation members. Texture, sequence, thickness, and magnetic beds serve as a basis for correlation. The Cuyuna Range is divided geographically, by the Northern Pacific Railroad, into a North Range and a South Range.

The Virginia, Biwabik, and Pokegama formations of the Cuyuna are correlated through the Emily district with the Mesabi series. The main or Biwabik iron formation of the Cuyuna North Range is made up of four members: the Upper Slaty, 1695-2300 feet thick, the Upper Cherty, 80-165 feet thick, the Lower Slaty, 700-750 feet thick, and the Lower Cherty, 100-250 feet thick. This section is much thicker than the Biwabik of the Mesabi. Overlying the Biwabik is a slate section over 5000 feet thick. If the slates did not contain a 200 foot thickness of iron formation, the South Range member, they would correlate well with the Virginia formation of the Mesabi. There is a possibility that there is only one ore horizon and the South Range member is a reappearance of the Biwabik. However, the character of the South Range member differs greatly from that of the Biwabik and it is separated by thousands of feet of barren slates from any other iron member. The Biwabik of the Cuyuna and the Mesabi are underlain by the Pokegama formation, quartzites and slates varying in thickness from less than 100 to greater than 350 feet.

The main producing area of the Cuyuna Range between Crosby and the Mississippi River consists of a series of complex folds and one or more faults. It is not the purpose of this paper to discuss the detailed structure of this area, but rather the more general structural features, especially those between the North Range and Mille Lacs.

South of the South Range, in the vicinity of Bay Lake, iron formation has been drilled that may represent the lower Slaty member of the Biwabik formation. Since the South Range member has been mapped as a tight syncline southeast of Brainerd, it would appear that the Biwabik, which dips steeply to the south near Crosby, passes under the South Range member to appear again near Bay Lake. Iron formation, again somewhat similar to the Biwabik, has been drilled in section 30, T.46N. - R.25W. north of Mille Lacs. Quartzite resembling that of the Pokegama formation outcrops east of Dam Lake, section 34, T.47N. - R.25W.

Granitic gneiss, tonalite, and quartz monzonite have been mapped (Woyski, 1949) south and east of Mille Lacs. Basic intrusives are known to occur with the iron formations of the North and South Range and in the vicinity of Dam Lake.

An alternate interpretation of the geology has been suggested by R. G. Schmidt and C. E. Dutton of the U.S. Geological Survey. In their opinion there is one main iron-formation that produces all but a few percent of the ore from the district. "The main iron-formation is a persistent layer that varies in thickness from less than 100 feet to more than 500 feet. It is stratigraphically underlain by at least 2000 feet of light gray argillite and siltstone and local lenses of quartzite near the upper contact. The strata younger than the main iron-formation are gray or black argillite, partly carbonaceous, partly ferruginous, and are transitional into lenses of lean iron-formation at several horizons.

Because of the higher iron-content, the younger metasedimentary rocks have a higher specific gravity than those older than the main iron-formation. Tuffs and basaltic flows occur locally at the base of the younger metasedimentary rocks and possibly within the main iron-formation. The younger sequence is probably more than 2000 feet thick." (R.G.Schmidt, oral communication).

Instrumentation

Gravity

Gravity measurements were made using a Worden gravimeter. The meter has a small dial constant of 0.03494 milligals per division and a large dial constant of 6.05 milligals per division over the range used.

The Worden meter is essentially a sensitive spring balance. The same mass weighed at different locations will reflect any change in the earth's gravity. Fused quartz, which has a low coefficient of expansion, high elasticity, and no magnetic susceptibility, is used in the spring system of the meter. The basic mass of the quartz moving system is about five milligrams. The meter is reasonably rugged as a result of this low mass and subsequent low moment of inertia and also the high elasticity of the system. The meter drift caused by fatigue in the system is low and in a positive direction, varying only slightly with temperature change.

Elevations

Elevations were obtained with a continuous recording microbarograph, thermograph, and altimeter.

The continuous recording microbarograph, a null type aneroid barometer with a spring driven timing mechanism, will record a change in barometric pressure of 1/1000 inch of mercury which would correspond to an elevation change of one foot. The thermograph, also spring driven and continuous recording, records the temperature to $\pm$ 1°F. Field temperature is checked at each station with a mercury thermometer.

The altimeter is basically an aneroid barometer but to eliminate lag, drift, and excessive friction in the system, and to increase sensitivity, it is constructed as a null or zero gauging instrument. The analogy of comparing the normal aneroid to a spring scale and the altimeter to an analytical balance will illustrate the principle of operation. The altimeter is calibrated in one foot divisions. It is temperature compensated and is calibrated for a temperature of 50 degrees F.

FIELD PROCEDURE

Field operations were commenced on June 25, 1955, at Crosby, Minnesota. The first few days were spent in gathering maps and bench mark descriptions and in becoming familiar with the area. Gravity traverses were planned along north-south roads using a station spacing of one mile, with closer spacing in anomalous areas. Parallel traverses were to be run every two to three miles. During the course of the summer, however, many of these traverses had to be altered because of road conditions.

The microbarograph and thermograph were set up each morning at a location convenient to the site of field operations. The gravimeter was then read at a base station and the level bubble adjustment checked to insure that the total gravity field was being measured. As base stations, the concrete pump base of an abandoned gas station at the corner of highway 210 and 3rd Street SW, Crosby, the elevation of which was known from a Minnesota Highway Department survey, and the NE corner of the Aitkin County court house adjacent to the U. S. C. G. S. bench mark were chosen. The Crosby base station was tied to gravity pendulum stations at Brainerd and Grand Rapids, Minnesota. As a check on the values obtained, two stations which had been occupied by Adams, whose gravity values are tied to Thiels, were occupied.

The gravity base was generally occupied three times a day for drift control. A station from each day's traverse was re-occupied at a later date as a check. The maximum allowable error was 0.20 milligals. The average error was found to be about 0.08 milligals.

Elevations were obtained, during favorable weather, at the same time the station was occupied for a gravity observation. Elevation control was obtained by tying into bench marks and other points of known elevation during the day as well as making several checks back to the base station for drift control. Although the altimeter was temperature compensated, drift was sometimes rather erratic and excessive. Normal diurnal change in atmospheric pressure resulted in apparent changes in elevations of up to 100 feet. Local pressure variations also resulted in some erratic elevation ties. Maximum allowable error of closure was three feet. If tie and check station readings did not indicate this accuracy, the traverse was re-run at a later date.

Reduction of Data

Gravity

The observed gravity values include the effect of several factors which must be eliminated if they are to reflect changes in geologic structure. Corrections which must be applied are meter drift and tidal effects, elevation, latitude, and terrain.

Drift Correction. The drift correction includes the effect of mechanical drift in the meter system and tidal effects. The gravity base station is read at two to four hour intervals during the day and the correction is made assuming linear drift between each check. The drift in the meter used for this survey was generally low and in a positive direction, averaging about 0.03 milligals per hour.

Elevation Correction. If gravity values are to be compared, they must be reduced to a common datum. This is accomplished by the free air and the Bouguer correction. The free air correction compensates for the decrease in gravity with elevation without regard to the mass between the station and datum. This correction has been shown to be 0.09406 milligals per foot.

The effect of the mass between the station and the datum can be calculated by assuming some simple geometric form, such as a disk of infinite radius. The gravitational effect of such a mass can be shown to be $\Delta g = g\,3/2\,\frac{d}{\sigma}\cdot\frac{H}{R}$ where d is the density of the material in the disk, σ the mean density of the earth, H the distance from station to datum, and R the radius of the earth. The Bouguer correction and free air correction are always of opposite sign.

In practice the two corrections are combined to give an elevation correction factor. This author assumed d to equal 2.67 to give an elevation factor of 0.06 milligals per foot.

Latitude Correction. Gravity increases towards the poles because of the flattening of the earth at the poles and the earth's rotation. The gravity at any latitude, ϕ, can be calculated from the international gravity formula, $g = 978.049(1 + 0.0052885 \sin^2\phi - 0.0000059 \sin^2 2\phi)$. The change of gravity in a north-south direction is found to be about 1.307 sin 2ϕ milligals per mile.

As a reference latitude this author chose 46° 30' 00" which resulted in a correction of 1.305 milligals per mile. The correction value was assumed constant over the area covered by this survey. The correction values were obtained by scaling the distance from the reference latitude to the station on the U.S.G.S. topographic maps. Corrections are added to stations south of the reference latitude and subtracted from stations to the north.

Terrain Correction. In regions of rough topography a terrain correction must be applied. In the area covered by this survey and for the accuracy desired terrain corrections were not necessary.

The above corrections are added algebraically to the Δg values obtained by subtracting the corrected base reading from the station reading and multiplying by the dial constant. A constant may be added to these relative, arbitrary values to give the results in terms of absolute gravity.

Reduction of Gravity to Absolute Values. Traverses were run from the Crosby base station to the gravity pendulum stations at Grand Rapids and Brainerd, Minnesota, and to Adams' gravity stations in Crosby and Aitkin. The Bouguer anomalies in Grand Rapids and Brainerd are given as -54 milligals and -28 milligals respectively. Adams has given the absolute gravity of his Crosby and Aitkin stations as 980.85762 gals and 980.66875 gals. Calculation of the Bouguer gravity at these stations using the international gravity formula $g = 978.049\ (1 + 0.0052884 \sin^2 \phi - 0.0000059 \sin^2 2\phi)$ d equals 2.67, and datum equal to mean sea level indicates a Bouguer anomaly of -26.2 milligals at Aitkin, and -29.8 milligals at Crosby. An error of closure of about 3 milligals between the two pendulum stations was noted. The Grand Rapids station is probably the more accurate, the work being done in 1940, whereas the Brainerd station was established in 1915. The tie between Adams' work and Grand Rapids station is less than one milligal, well within the probable error of pendulum measurements.

Values on the Bouguer gravity map are reduced to tie to the work completed by Adams and Theil.

Elevations

Elevations obtained with an altimeter must be corrected for variations in atmospheric pressure and air temperature. A recording microbarograph and thermograph are used at a base station and pressure fluctuations are assumed constant over the given area. The air temperature is noted at each station.

The altimeter elevations are first corrected for variations in atmospheric pressure as indicated by the microbarograph record. A change in pressure of 1/1000 inch of mercury results in an apparent change in elevation of approximately one foot. By comparing the corrected elevations of a base station that has been re-occupied during the day, the altimeter drift curve can be determined and a drift correction applied.

A correction allowing for the variation in the weight of a column of air between stations of different elevation and temperature is made. If air were a true gas, its density would be inversely proportional to the absolute temperature. The altimeter, like most aneroid barometers, is calibrated for 50 degrees F or 510 degrees absolute. Therefore, a one degree change in temperature should cause a change in density, and pressure, of 1/511 or 0.1961 per cent. Actually the rate of change is 0.2039 per cent for each degree above or below 50 degrees F. The correction can be approximated by taking the sum of the station and base temperature and applying a plus or minus correction of 0.1 per cent of the difference in elevation for each degree that this sum is above or below 100 degrees F.

The corrected difference in elevation between the station and the base is added algebraically to the known base elevation to give the corrected station elevation.

INTERPRETATION OF GRAVITY DATA

In considering the interpretation of the Bouguer gravity map, it must be remembered that, with the station spacing used and the precision of the survey, only the major structural features will be outlined. The probable error of the station values is greater than the anomalies that minor structures would produce.

The greatest problem in interpretation is the lack of density information. For reduction of data a d of 2.67 was assumed. This would seem to be a satisfactory choice as there appears to be no consistent relation between gravity and topography. The bedrock surface is believed to be fairly uniform and should not give rise to any anomalies. It would be almost impossible to assign an average density to any given formation on the Cuyuna Range because of many facies changes, though the slates and the schists may be an exception to this. As a result any theoretical cross sections and calculations are very hypothetical. The only solution to this problem would be a detailed, but time-consuming, study of all existing drill hole information.

Specific gravity determinations of drill core samples from northern Crow Wing county have been made by the Oliver Iron Mining Division with the following results: (Ralph Marsden and Richard Strong, oral communication)

Description	No. of Samples	Range	Avg. Sp. G.
Hanging Wall			
Slate	10	2.08-2.78	2.44
Upper iron formation	30	2.33-3.22	2.78
Graywacke	23	2.22-2.71	2.82

Description	No. of Samples	Range	Avg. Sp. G.
Main Iron Formation			
Ferruginous chert	3	2.65-2.70	2.67
Thin bedded i. f.	4	3.18-3.50	3.32
Footwall			
Slaty banded quartzite	23	2.38-2.77	2.56
Variegated slate	4	2.34-2.83	2.61
Quartzite	9	2.51-2.73	2.64
Dolomite	2	2.84-2.86	2.85
Unclassified	4	2.41-2.58	2.50

The descriptions of the locations where these samples were taken are not available. This author believes that, if more samples were taken of the hanging wall slate, a higher average density would be found. Three of the 10 samples had a specific gravity of greater than 2.7.

The gravity picture over the active portion of the North Range is of importance as the geology is fairly well known, and relations that hold here can be used to explain anomalies in adjacent areas. The station density is not great enough to note the smaller folds, but only the major structures. It is noted that broad positive gravity anomalies are associated with synclinal structures while sharper positive anomalies are associated with the steeply dipping flanks of a structure and areas of tight folding. Anticlines seem to produce negative anomalies as the lower density quartzites and schists are brought nearer the surface and a portion or all of the dense iron formation is removed by erosion. This is illustrated in sections 6, 7, and 17, T.46N. - R.29W. A syncline exposing the Lower Slaty and Lower Cherty members trends southwesterly from Mahnomen Lake with quartzite exposed at the erosion surface on each flank. Gravity relief of two milligals is seen between the positive anomaly over the axis of the syncline and the gravity lows over the adjacent anticlines.

The positive gravity anomaly in the Rabbit Lake area is again associated with a synclinal structure. The anomaly is sharper and of greater magnitude than noted elsewhere because of tight folding within the structure.

The contact between the Virginia formation and the Biwabik iron formation has been mapped (Grant and Wolff, 1955, pl 1) at the north edge of Crosby striking northeast. A low magnitude positive anomaly follows the contact towards Rabbit Lake. The negative gravity anomaly through Serpent Lake to the immediate south could result from monoclinal folding of the iron formation under the slates if Grout's concept of the structure is assumed. However, if Schmidt's geologic section is correct, this is an anticlinal area and a negative anomaly is expected. In order to substantiate either structure, detailed traverses across the area are needed to determine the magnitude of the anomaly and the gradients.

The main gravity feature is a narrow positive anomaly extending from a broad positive anomaly south of Brainerd northeastward through Aitkin and extending eastward for an undetermined distance. The axis of the high is centered between the South Range and the iron formation at Bay Lake. Again two interpretations are possible, one based on the geology as seen by Grout and the other based on Schmidt's geologic section.

This gravity feature and geological evidence presented by Grout would suggest a syncline where the Virginia slates, less dense than the Biwabik but denser than the underlying Pokegama, lie in a basin of thinning Biwabik iron formation. The second order anomalies are due to folding within the syncline. Southeast of Brainerd the positive anomaly divides into two highs separated by a shallow negative anomaly. This suggests a rather

pronounced anticline within the synclinal structure. The offset of the positive anomaly through section 1, T.44N. - R.31W. to the south of the geologically mapped syncline of the South Range iron formation is caused by the steep south dip of the axial plane of the syncline. A second high striking southwest through section 31, T.45N. - R.29W. shows evidence that it may, south of the map area, swing eastward through central Mille Lacs to partly enclose the large negative anomaly north of Mille Lacs.

The anomaly south of the South Range can be duplicated with calculations based on Schmidt's geologic section. Assuming the North and South Range are the same stratigraphic horizon, an anticlinal structure is present between the North and South Ranges with the iron formation removed by erosion leaving slates and siltstones at the erosion surface. The South Range and the iron formation at Bay Lake are the north and south limbs of a syncline containing a section of dense ferruginous slates which give rise to the anomaly. The rather pronounced gravity low which is expected north of the South Range is not indicated but the formation here may be denser than expected.

The large negative anomaly north of Mille Lacs may result from an anticlinal structure and is possibly related to an acidic intrusive. There is little geologic evidence to support the latter idea. The negative anomaly can be duplicated by a theoretical acidic intrusive mass about 200 feet below the surface, 15,000 feet thick, and roughly circular with a diameter of 19,000 feet. A density contrast of 0.15 is assumed.

Iron formation, somewhat similar to that of the North Range found in section 19, 20, and 30, T.46N. - R.25W. associated with a quartzite, may be the south limb of the suggested anticline. Although this quartzite

does not resemble the Dam Lake quartzite, Harder and Johnston suggested a quartzite, stratigraphically lower than the iron formation may run from Dam Lake to near Bay Lake (Harder and Johnston, 1918). The iron formation is probably cut off to the east and to the south under Mille Lacs by intrusives. There is a second order negative anomaly associated with the quartzite which outcrops at Dam Lake. The positive anomaly south of Dam Lake is probably associated with basic intrusives. Additional gravity coverage is needed east of this region.

North of the Mississippi River the gravity picture is less interesting. The contouring of the broad positive anomaly about 10 miles east of Emily is questionable because of the few gravity stations established in the area. A thick section of ferruginous slates could produce the anomaly. The contact of the iron formation and the slate is believed to strike south through this area in a series of folds and then to swing northeastward towards Pallisade towards the gravity high mapped in T.49N. - R.25W.

Between Crosby and Emily the gravity trends generally follow the iron formation. Gravity work north and east of Emily would be of interest as geological maps indicate folding of the iron formation similar to that on the Cuyuna Range.

North of Pelican Lake, T.137N. - R.28W., there is a pronounced positive gravity anomaly, probably caused by a dolomite stratigraphically lower than the iron formation. A negative anomaly begins north of this positive anomaly over what may be a granite area. Since only one traverse was made to Pelican Lake, the trends could not be contoured.

Interpretation of Magnetic Data

The Geological Survey has available aeromagnetic maps covering the portion of Crow Wing County included in this gravity survey. A comparison of the gravity and magnetic anomalies helps substantiate the gravity interpretation.

The magnetic picture over the active portion of the Cuyuna Range is not too clear because of the one mile spacing of the flight lines and because of the complex structure of the area. Areas of enriched ore may be less magnetic than fresh iron formation as a result of oxidation. Facies changes often make it impossible to trace some magnetic members more than a few miles.

A narrow, high magnitude, positive magnetic anomaly is associated with the South Range member. South of Brainerd the anomaly divides into two parallel positive anomalies where the syncline containing the South Range member apparently broadens. A positive magnetic anomaly occurs to the north of the iron formation found at Bay Lake. This offset is expected if the iron formation dips northwest as the south limb of a syncline. Also Grout believes that this iron formation may represent the lower part of the Lower Slaty member of the Biwabik (Grout and Wolff, 1955, p 88). If this is correct, magnetic beds stratigraphically higher would occur further north. The magnetic expression of this iron formation can be traced about six miles.

A rather broad positive magnetic anomaly extends from T.43N.-R.29W. through T.44N. - R.28W. and probably through the negative gravity anomaly north of Mille Lacs. A portion of the magnetic anomaly is due to intrusives north of Mille Lacs, but to the west it is difficult to explain as it does not correlate with gravity trends, although it does correspond roughly to an area of gneiss mapped by Woyski (1949, pl 1).

A narrow positive anomaly closely follows the Mississippi River north of Brainerd. Although no gravity anomaly was noted in this area, the author feels that a gravity survey of higher accuracy would reveal a low magnitude anomaly. Geological indications imply a western extension of the iron formation from the active portion of the range.

CONCLUSIONS

The following conclusions were drawn from the results of this investigation:

1. The South Range is associated with a synclinal structure either as a stratigraphically higher iron formation in an elongated trough of Biwabik iron formation or, assuming one iron formation, as the north limb of a syncline, the south limb being represented by the iron formation at Bay Lake.
2. The negative gravity anomaly north of Mille Lacs is the result of a granitic intrusive.
3. No gravity anomaly is noted between the North Range and Brainerd although magnetic data and geological consideration suggest a westward extension of the North Range iron formation.
4. Gravity provides an excellent means of prospecting, both on a regional and local scale on the Cuyuna Range.

References

Adams, F.S., 1910, The Iron Formation of the Cuyuna Range. Econ. Geology, v.5, p.729-39.

Cheney, C.A., 1915, "Structure of the Cuyuna Iron Ore District Minnesota. Eng. and Min. Journal, v.99, p. 113-115.

Emmons, W.H. and Grout, F.F., 1943, Mineral Resources of Minnesota: Manganese. Minnesota Geol. Survey Bull. 30.

Grout, F.F. and Wolff, J.F., Sr., 1955, The Geology of the Cuyuna District, Minnesota. Minnesota Geol. Survey Bull. 36.

Harder, E.C. and Johnston, A.W., 1918, Preliminary Report on the Geology of East Central Minnesota Including the Cuyuna Iron Ore District. Minnesota Geol. Survey Bull. 15.

Leith, C.K., 1907, The Geology of the Cuyuna Iron Range, Minnesota. Econ. Geology, v. 2, p. 145-52.

Leverett, F. and Sardeson, F., 1919, Surface Formations and Agricultural Conditions of the South Half of Minnesota. Minnesota Geol. Survey Bull. 14.

Nettleton, L.L., 1942, Gravity and Magnetic Calculations. Geophysics, v.7, p.293-310.

Thiel, G.A., 1927, Geology of the Cuyuna Range. Geol. Soc. America Bull., v.38, p.783-94.

VanHise, C.R. and Leith, C.K., 1911, The Geology of the Lake Superior Region. U.S.Geol. Survey Monograph 52.

Winchell, N.H., 1907, The Cuyuna Iron Range. Econ. Geology, v.2, p.565-71.

Woyski, Margaret S.,1949, Intrusives of Central Minnesota. Geol. Soc America Bull., v.60, p.999-1016.

Zapfee, C., 1928, Geologic Structures of the Cuyuna District, Minnesota. Econ. Geology, v. 23, p.612-46.

Zumberge, J.H., 1952, The Lakes of Minnesota, Their Origin and Classification. Minnesota Geol. Survey Bull. 35.

Appendix

GRAVITY DATA

Project Owyhee Range Operator G. A. Barfen Date July 6, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	k	g	Elev.	Corrections Elev.	Lat.	Cor. g	Meso	g
11	8:58	574	172	574	0							
49	9:23	714	172	573	+141	+4.93	Tie — -0.17 mg					
116	9:43	541	172	572	-31	-1.08	1240	+14.40	-3.74	9.58	-47.3	-37.7
117	9:57	537	172	572	-35	-1.22	1215	+12.90	-4.43	7.25	-47.3	-40.1
118	10:15	682	172	571	+111	+3.87	1230	+13.80	-3.41	14.26	-47.3	-33.0
119	10:28	590	172	571	+19	+0.66	1247	+14.82	-3.04	12.44	-47.3	-34.9
120	10:40	664	172	570	+94	+3.29	1222	+13.32	-3.02	13.59	-47.3	-33.7
121	10:53	699	172	570	+129	+4.51	1210	+12.60	-3.72	14.39	-47.3	-32.9
122	11:07	727	172	569	+158	+5.52	1210	+12.60	-4.35	13.77	-47.3	-33.6
123	11:17	718	172	569	+149	+5.21	1210	+12.60	-5.02	12.79	-47.3	-34.5
124	11:25	702	172	568	+134	+4.68	1209	+12.54	-5.68	11.54	-47.3	-35.8
125	11:36	713	172	568	+145	+5.07	1209	+12.54	-6.62	10.99	-47.3	-36.3
126	11:55	710	172	567	+143	+5.00	1203	+12.18	-6.85	10.33	-47.3	-37.0
11	12:28	566	172	566	0							
127	2:00	661	172	568	+93	+3.25	1225	+13.50	-1.74	15.01	-47.3	-32.3
128	2:10	712	172	568	+144	+5.04	1201	+12.06	-3.03	14.07	-47.3	-33.2
129	2:25	748	172	568	+180	+6.30	1179	+11.99	-4.35	13.89	-47.3	-33.4
130	2:38	775	172	568	+207	+7.24	1206	+12.36	-5.64	13.96	-47.3	-33.3
131	2:50	803	172	568	+235	+8.22	1200	+12.00	-6.96	13.26	-47.3	-34.0
132	3:03	806	172	569	+237	+8.28	1208	+12.48	-7.27	13.49	-47.3	-33.8
133	3:27	597	172	569	+28	+0.98	1249	+14.94	-1.76	14.16	-47.3	-33.1
134	3:45	618	172	569	+49	+1.71	1250	+15.00	-0.06	16.65	-47.3	-30.7
46	4:05	465	172	570	-105	-3.67	Tie — +0.04 mg					
11	4:25	570	172	570	0							

GRAVITY DATA

Project Cayuna Range Operator G. A. Durfee Date July 7, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	Δ	g	Elev.	Correction Elev.	Correction Lat.	Cor.	g	Base	g
11	9:08	578	172	578	0								
135	9:50	663	172	577	+86	+3.01	1192	+11.52	-4.96	9.57	-47.3	-37.7	
136	10:05	633	172	577	+56	+1.96	1230	+13.40	-4.50	9.26	-47.3	-38.0	
137	10:15	709	172	577	+132	+4.61	1212	+14.78	-7.87	10.11	-47.3	-37.2	
138	10:23	701	172	577	+124	+4.33	1216	+12.26	-7.76	9.53	-47.3	-37.8	
139	10:37	701	172	576	+125	+4.37	1242	+14.50	-8.08	9.81	-47.3	-37.5	
140	10:50	740	172	576	+164	+5.73	1225	+13.50	-7.06	10.17	-47.3	-37.1	
Tie	11:10	731	172	576									
141	11:19	712	172	576	+136	+4.75	1261	+19.66	-10.10	10.31	-47.3	-37.0	
142	11:28	761	172	576	+185	+6.47	1218	+13.00	-9.68	10.47	-47.3	-36.8	
143	11:40	766	172	575	+191	+6.68	1209	+12.54	-7.94	11.28	-47.3	-36.0	
11	12:08	575	172	575	0								

GRAVITY DATA

Project Cayuna Range Operator G. A. Durfee Date July 8, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Corrections Elev.	Corrections Elev.	Corrections Lat.	Corrections Cor.	g	Base	g
11	8:55	608	172	608	0								
47	9:13	716	172	608	+108	+3.77	Tie — +0.14 mg						
75	9:33	560	174	608	-48	+10.42	Tie — +0.07 mg						
144	9:58	638	174	609	+29	+13.11	1299	+17.94	-20.46	10.59	-47.3	-36.7
145	10:10	697	174	609	+88	+15.18	1258	+15.48	-19.31	11.35	-47.3	-35.9
146	10:21	632	174	609	+23	+12.90	1278	+15.60	-15.66	10.92	-47.3	-36.4
147	10:33	633	174	609	+24	+12.94	1250	+15.00	-17.25	10.69	-47.3	-36.6
148	10:52	567	174	609	-42	+10.63	1249	+14.94	-16.20	9.37	-47.3	-37.9
74	11:15	667	174	609	+58	+14.13	1253	+15.18	-14.92	14.39	-47.3	-33.9
149	11:27	515	174	610	-95	+8.70	1269	+16.14	-14.27	10.65	-47.3	-36.6
150	11:43	529	174	610	-81	+9.27	1238	+14.28	-12.87	10.68	-47.3	-36.6
11	12:20	610	172	610	0								
11	12:25	403	172	403	0								
60	2:05	286	172	404	-118	-4.12	Tie — +0.03 mg						
151	2:20	365	172	404	-39	-1.36	1246	+14.76	+15.29	28.69	-47.3	-18.6
152	2:30	379	172	404	-25	-0.87	1259	+15.54	+14.61	29.28	-47.3	-18.0
153	2:39	427	172	404	+23	+0.80	1255	+15.36	+14.00	30.16	-47.3	-17.1
154	2:50	438	172	404	+34	+1.19	1262	+15.72	+13.35	30.26	-47.3	-17.0
155	3:00	431	172	404	+27	+0.94	1268	+16.08	+12.70	29.72	-47.3	-17.6
156	3:13	366	172	404	-38	-1.33	1279	+16.74	+11.98	27.39	-47.3	-19.9
157	3:24	299	172	404	-105	-3.67	1262	+15.72	+11.41	23.46	-47.3	-23.8
158	3:34	373	172	405	-32	-1.12	1250	+15.00	+11.43	25.31	-47.3	-22.0
159	3:43	308	172	405	-97	-3.39	1245	+14.70	+11.94	22.25	-47.3	-25.1
160	3:52	327	172	405	-78	-2.73	1226	+13.56	+10.06	20.89	-47.3	-26.4
161	4:03	350	172	405	-55	-1.75	1218	+13.08	+8.76	20.09	-47.3	-27.2
12	4:17	269	172	405	-136	-4.75	Tie — 0.00 mg						
11	4:30	405	172	405	0								

GRAVITY DATA

Project Cayuna Range Operator G. A. Durfee Date July 11, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Corrections Elev.	Elev.	Lat.	Cor.	g	Base	g
11	8:10	480	172	480	0								
162	9:20	501	172	483	+18	+0.63	1238	+11.30	+13.36	28.29	-47.3	-19.0
163	9:28	463	172	483	-20	-0.70	1250	+15.00	+14.03	28.33	-47.3	-19.0
164	9:38	339	172	483	-144	-5.03	1292	+17.51	+15.22	27.77	-47.3	-19.5
165	9:45	398	172	483	-85	-2.97	1262	+15.73	+16.53	29.29	-47.3	-18.0
166	9:55	351	172	484	-133	-4.65	1280	+16.80	+17.24	30.09	-47.3	-17.2
167	10:05	313	172	484	-171	-5.97	1278	+16.78	+19.26	29.94	-47.3	-17.3
168	10:12	270	172	484	-214	-7.46	1277	+16.71	+20.55	29.70	-47.3	-17.6
169	10:20	275	172	485	-210	-7.34	1272	+16.32	+21.87	30.85	-47.3	-16.4
170	10:30	316	172	485	-169	-5.90	1236	+14.16	+21.86	30.12	-47.3	-17.2
171	10:43	334	172	486	-152	-5.31	1244	+14.65	+20.55	29.89	-47.3	-17.4
172	10:55	346	172	486	-140	-4.89	1255	+15.31	+19.30	29.72	-47.3	-17.6
173	11:03	343	172	486	-143	-5.00	1284	+17.04	+17.98	30.02	-47.3	-17.3
60	11:20	371	172	487	-116	-4.05	Tie — -0.04 mg						
158	11:43	459	172	488	-29	-1.02	Tie — -0.10 mg						
11	12:05	489	172	489	0								
11	1:25	490	172	490	0								
110	1:50	683	172	490	+193	+6.75	Tie — +0.03 mg						
174	2:05	432	172	490	-58	-2.03	1280	+16.80	+5.19	18.96	-47.3	-28.3
175	2:23	460	172	490	-30	-1.05	1234	+17.04	+3.51	20.10	-47.3	-27.2
176	2:35	338	172	490	-152	-5.31	1306	+18.35	+3.49	16.53	-47.3	-30.8
177	2:50	498	172	491	+7	+0.24	1278	+16.70	+2.16	19.10	-47.3	-28.2
178	3:04	740	172	491	+249	+8.70	1208	+12.49	+3.95	22.14	-47.3	-25.2
179	3:15	757	172	491	+266	+9.30	1204	+12.25	+0.51	22.06	-47.3	-25.2
180	3:33	760	172	491	+269	+9.40	1197	+11.83	-1.41	19.82	-47.3	-27.5
11	4:28	491	172	491	0								

GRAVITY DATA

Project Cuyuna Range Operator G. A. Durfee Date July 12, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Elev	Corrections Elev.	Corrections Lat.	Cor.	g	Base	g
11	7:55	492	172	492	0								
176	8:38	341	172	493	-152	-5.32	Tie — +[illegible].01 mg						
181	8:50	251	172	493	-242	-8.46	1306	+10.36	+4.79		14.69	-47.3	-32.6
182	9:07	236	172	494	-258	-9.02	1302	+10.12	+5.46		14.56	-47.3	-32.7
183	9:25	212	172	494	-282	-9.86	1302	+10.12	+6.32		14.58	-47.3	-32.7
184	9:37	229	172	495	-266	-9.30	1274	+16.44	+6.82		13.96	-47.3	-33.3
185	9:48	178	172	495	-317	-11.08	1290	+17.40	+7.44		13.76	-47.3	-33.5
186	10:02	150	172	495	-345	-12.06	1275	+16.50	+8.54		12.98	-47.3	-34.3
187		Off Scale					1271	+16.26					
11	11:37	498	172	498	0								

GRAVITY DATA

Project Sonora Range Operator G. A. Durfee Date July 13, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Cor. g	Base	g
11	8:08	484	172	484	0							
185	9:03	276	172	484	-208	-7.28	1218	+13.08	+4.23	10.03	-47.3	-37.3
186	9:21	295	172	485	-190	-6.64	1213	+12.78	+3.42	9.56	-47.3	-37.6
187	9:30	282	172	485	-197	-6.88	1214	+12.84	+2.52	8.48	-47.3	-38.8
188	9:46	311	172	485	-174	-6.08	1216	+12.96	[illegible]	6.88	-47.3	-40.4
189	9:56	336	172	485	-149	-5.21	1220	+13.20	[illegible]	7.99	-47.3	-39.3
190	10:07	308	172	485	-177	-6.18	1220	+13.20	+0.58	7.60	-47.3	-39.7
191	10:19	304	172	485	-181	-6.32	1220	+13.20	+1.70	8.58	-47.3	-38.7
192	10:35	285	172	485	-200	-6.99	1217	+13.02	+2.57	8.60	-47.3	-38.7
193	10:47	292	172	485	-193	-6.74	1217	+13.02	+3.24	9.52	-47.3	-37.8
194	11:03	308	172	485	-177	-6.88	1219	+13.14	+3.86	10.12	-47.3	-37.2
195	11:13	317	172	485	-168	-5.87	1205	+12.30	+4.09	10.52	-47.3	-36.8
196	11:23	302	172	485	-183	-6.40	1218	+13.08	+3.89	10.57	-47.3	-36.7
197	11:31	281	172	486	-205	-7.17	1219	+13.14	+3.60	9.57	-47.3	-37.8
185	11:50	278	172	486	-208							
161	12:17	433	172	486	-53	-1.85	Tie — +0.10 mg					
11	12:37	486	172	486	0							
198	1:55	300	172	485	-185	-6.46	1227	+13.62	+3.54	10.70	-47.3	-36.6
199	2:12	448	172	485	-37	-1.29	1187	+11.22	+2.83	11.96	-47.3	-35.3
200	2:25	414	172	485	-71	-2.48	1212	+12.72	+2.95	12.29	-47.3	-35.0
201	2:37	389	172	485	-96	-3.35	1204	+12.24	+1.97	10.86	-47.3	-36.4
202	3:15	451	172	484	-33	-1.15	1178	+11.68	[illegible]	9.53	-47.3	-37.8
11	3:50	484	172	484	0							

GRAVITY DATA

Project Cuyuna Range Operator G. A. Durfee Date July 14, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Corrections Elev.	Elev.	Lat.	Cor.	g	Base	g
11	12:50	528	173	528	0								
176	1:20	337	173	529	-153	-5.36	Tie — -0.04 mg						
187	2:10	253	172	530	-277	-15.73	1271	+16.26	+8.84	9.37	-47.3	-37.9	
203	2:19	154	172	531	-377	-19.24	1279	+16.74	+10.04	7.54	-47.3	-39.8	
204	2:30	364	170	531	-167	-23.98	1306	+18.36	+11.32	5.70	-47.3	-41.6	
205	2:40	277	170	531	-254	-27.02	1283	+16.98	+12.15	2.11	-47.3	-45.2	
206	2:52	271	170	532	-261	-27.27	1269	+16.14	+12.65	1.52	-47.3	-45.8	
207	3:04	287	170	532	-245	-26.71	1263	+15.78	+13.93	3.00	-47.3	-44.3	
208	3:15	293	170	533	-240	-26.54	1262	+15.72	+15.20	4.38	-47.3	-42.9	
97	3:58	582	170	534	+48	-16.46	Tie — +0.15 mg						
11	4:35	535	173	535	0								

GRAVITY DATA

Project Guyana Range Operator G. A. Durfee Date June 22, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Cor. g	Base	g
1	2:35	459	172	488	-29	-1.01	1280	+16.88	+2.70	18.49	-47.3	-28.8
2	2:55	550	172	488	+62	+2.17	1283	+16.99	+3.62	22.78	-47.3	-24.5
3	3:05	523	172	488	+35	+1.22	1274	+16.45	+4.07	21.74	-47.3	-25.5
4	3:15	504	172	488	+16	+0.56	1279	+16.21	+5.03	21.80	-47.3	-25.5
5	3:30	391	172	488	-97	-3.39	1301	+18.06	+6.14	20.81	-47.3	-26.5
6	3:35	319	172	488	-169	-5.90	1296	+17.76	+7.44	19.30	-47.3	-28.0
7	3:45	289	172	487	-198	-6.92	1272	+16.32	+8.32	17.72	-47.3	-29.6
8	4:00	169	172	487	-318	-11.12	1322	+1[illegible].32	+9.28	17.48	-47.3	-29.8
9	4:10	182	172	487	-305	-10.66	1300	+18.09	+10.55	17.89	-47.3	-29.4
10	4:25	172	172	487	-315	-11.01	1297	+17.82	+12.65	19.46	-47.3	-27.8
1	4:50	459	172	488	-29							

GRAVITY DATA

Project Guyuna Range Operator G. A. Durfee Date June 24, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Cor. g	Base	g
11	8:55	525	172	525	0	0	1256	+15.35	+1.71	17.06	-47.3	-30.2
12	9:23	389	172	525	-136	-4.75	1232	+13.92	+4.76	18.68	-47.3	-33.4
13	9:33	382	172	525	-143	-5.00	1230	+13.80	+4.57	18.37	-47.3	-33.9
14	9:40	376	172	525	-149	-5.21	1232	+13.92	+4.05	17.97	-47.3	-34.5
15	9:55	373	172	525	-152	-5.32	1220	+13.20	+3.46	16.66	-47.3	-36.0
16	10:00	402	172	525	-123	-4.30	1226	+13.56	+2.69	16.25	-47.3	-35.3
17	10:16	437	172	525	-88	-3.07	1202	+12.12	+2.24	14.36	-47.3	-36.0
18	10:26	413	172	525	-112	-3.91	1227	+13.63	+1.84	15.47	-47.3	-35.7
19	10:35	508	172	525	-17	-0.59	1197	+11.82	+1.08	12.90	-47.3	-35.[illegible]
20	10:45	465	172	525	-60	-2.10	1210	+13.15	+0.50	13.65	-47.3	-35.7
21	10:54	450	172	525	-75	-2.62	1224	+13.45				
22	11:03	514	172	525	-11	-0.38	1206	+12.36	-0.32	11.66	-47.3	-35.6
23	11:11	482	172	525	-43	-1.50	1224					
11	11:57	525	172	525	0	0	1256					

GRAVITY DATA

Project Cuyuna Range Operator G. A. Durfee Date June 27, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Baro	K	g	Elev.	Corrections Elev.	Corrections Lat.	Cor. g	Base	g
11	8:15	500	172	500	0							
24	8:40	407	172	500	-93	-3.25	1241	+14.46	+4.[illegible]	15.29	-47.3	-32.0
25	9:05	394	172	501	-107	-3.74	1268	+16.[illegible]	+4.20	16.54	-47.3	-30.8
26	9:20	389	172	501	-112	-3.91	1256	+15.36	+5.00	16.45	-47.3	-30.9
27	9:40	336	172	501	-165	-5.76	1272	+16.32	+6.72	17.28	-47.3	-30.0
28	10:05	332	172	502	-170	-5.94	1260	+15.60	+7.36	17.02	-47.3	-30.3
29	10:25	359	172	502	-143	-5.00	1252	+15.12	+8.76	18.88	-47.3	-28.4
30	10:55	396	172	503	-107	-3.74	1262	+15.72	+9.72	21.70	-47.3	-25.6
31	11:20	476	172	503	-27	-0.94	1256	+15.36	+13.03	24.45	-47.3	-22.8
11	12:15	504	172	504	0							
32	1:45	430	172	502	-72	-2.51	1242	+14.52	+9.[illegible]	21.96	-47.3	-25.0
31	2:05	475	172	501	-26	-0.91	Tie — +0.02 mg					
33	2:25	446	172	501	-55	-1.92	1276	+16.56	+10.07	24.71	-47.3	-22.6
34	2:40	448	172	501	-53	-1.85	1260	+15.60	+11.40	25.15	-47.3	-22.1
35	2:58	490	172	500	-10	-0.35	1235	+14.10	+12.70	26.45	-47.3	-20.9
36	3:15	453	172	500	-47	-1.64	1239	+14.34	+12.69	25.39	-47.3	-21.9
37	3:30	472	172	499	-27	-0.94	1225	+13.50	+11.61	24.17	-47.3	-23.1
38	3:48	412	172	499	-87	-3.04	1260	+15.60	+10.00	22.56	-47.3	-24.7
39	4:00	437	172	499	-62	-2.17	1253	+15.16	+8.75	21.76	-47.3	-25.5
40	4:25	446	172	498	-52	-1.82	1266	+15.96	+8.22	22.36	-47.3	-24.9
11	5:10	497	172	497	0							

GRAVITY DATA

Project Cayuna Range Operator G. A. Durfee Date June 28, 1955

Station	Time	Reading Sm. Dial	Reading Lg. Dial	Base	Δ	g	Elev.	Corrections Elev.	Corrections Lat.	Corrections Cor.	g	Base	g
11	8:10	494	172	494	0								
41	8:50	430	172	495	-65	-2.27	1262	+1[illegible].72	+[illegible].45	21.90		-47.3	-25.4
42	9:05	363	172	495	-132	-4.61	1274	+1[illegible].44	+[illegible].50	19.33		-47.3	-28.0
43	9:30	384	172	496	-112	-3.91	1269	+1[illegible].14	+6.17	1[illegible].40		-47.3	-28.9
44	9:38	396	172	496	-100	-3.49	1278	+1[illegible].60	+5.54	18.73		-47.3	-28.6
45	9:48	402	172	496	-94	-3.28	1272	+1[illegible].32	+4.79	17.83		-47.3	-29.5
46	10:09	393	172	497	-104	-3.63	1273	+1[illegible].38	+3.54	16.69		-47.3	-30.6
47	10:45	610	172	498	+112	+3.91	1215	+12.[illegible]	-3.[illegible]6	13.05		-47.3	-34.3
48	11:00	633	172	498	+135	+4.72	1216	+12.[illegible]6	-3.73	13.95		-47.3	-33.3
49	11:08	644	172	498	+146	+5.10	1220	+13.20	-3.65	14.65		-47.3	-32.7
50	11:18	652	172	499	+154	+5.38	1231	+13.[illegible]6	-3.26	15.[illegible]		-47.3	-31.3
51	11:35	758	172	499	+259	+9.06	1203	+12.[illegible]	-2.54	18.[illegible]0		-47.3	-28.6
52	11:50	767	172	499	+268	+9.37	1219	+13.14	-2.24	20.27		-47.3	-27.0
53	12:00	651	172	499	+152	+5.31	1249	+14.[illegible]4	-1.47	18.78		-47.3	-28.5
54	12:14	497	172	500	-3	-0.11	1298	+17.[illegible]8	-[illegible].91	16.86		-47.3	-30.4
55	12:30	462	172	500	-38	-1.33	1264	+15.04	+1.21	15.72			
11	1:10	501	172	501	0								
32	1:40	428	172	501	-73	-2.55	Tie -- +[illegible].04 [illegible]						
56	1:53	394	172	502	-1[illegible]8	-3.77	1267	+16.[illegible]2	+10.08	22.33		-47.3	-25.0
57	2:10	442	172	502	-60	-2.10	1258	+15.40	+13.35	26.73		-47.3	-20.6
58	2:25	527	172	502	+25	+0.87	1258	+15.40	+13.31	29.66		-47.3	-17.6
59	2:40	372	172	502	-130	-4.54	1292	+17.52	+15.24	28.22		-47.3	-19.1
60	2:55	396	172	503	-117	-4.09	1279	+16.74	+16.60	29.25		-47.3	-18.1
61	3:12	358	172	503	-145	-5.06	1267	+16.02	+16.60	27.56		-47.3	-19.7
62	3:25	415	172	503	-88	-3.07	1275	+16.50	+15.30	28.73		-47.3	-18.6
63	3:40	577	172	503	+74	+2.59	1248	+14.08	+12.04	29.51		-47.3	-17.8
11	4:20	504	172	504	0								

GRAVITY DATA

Project Guruna Range Operator C. A. Durfee Date June 29, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Cor.	g	Base	g
11	8:03	507	172	507	0								
64	8:35	568	172	507	+61	+2.13	1205	+12.30	-4.05	10.38	-47.3	-36.9
65	8:47	512	172	508	+4	+0.14	1222	+13.39	-5.55	7.91	-47.3	-39.4
66	9:00	463	172	508	-45	-1.57	1258	+15.48	-5.60	7.31	-47.3	-40.0
67	9:10	477	172	508	-31	-1.08	1281	+16.36	-7.90	7.88	-47.3	-39.4
68	9:25	490	172	508	-18	-0.63	1273	+16.33	-8.52	7.23	-47.3	-40.1
69	9:42	547	172	508	+39	+1.36	1264	+15.74	-9.19	8.01	-47.3	-39.3
70	10:00	617	172	509	+108	+3.77	1243	+14.58	-10.15	8.20	-47.3	-39.1
71	10:15	656	172	509	+147	+5.13	1245	+14.[illegible]	-11.71	8.12	-47.3	-39.2
72	10:35	670	172	509	+161	+5.62	1239	+14.34	-11.95	8.01	-47.3	-39.3
73	10:50	659	172	509	+150	+5.24	1265	+15.98	-13.30	8.14	-47.3	-39.2
74		Off Scale				+14.13	1253	+15.18	-14.92	14.39	-47.3	-32.9
75	11:58	806	172	510	+296	+10.35	1229	+13.74	-14.16	9.63	-47.3	-37.7
11	12:35	511	172	511	0								
76	3:25	556	172	509	+47	+1.64	1249	+14.94	-4.84	15.74	-47.3	-31.6
77	3:35	506	172	508	+78	+2.72	1229	+13.74	-1.76	14.70	-47.3	-32.6
78	3:45	604	172	508	+96	+3.35	1214	+12.84	-2.81	13.38	-47.3	-33.9
12	4:15	508	172	508	0								

GRAVITY DATA

Project Kayuna Range Operator G. A. Durfee Date June 30, 1955

Station	Time	Reading Sm. Dial	Reading Lg. Dial	Base	%	g	Elev.	Corrections Elev.	Lat.	Cor.	g	Base	g
11	9:00	501	172	501	0								
79	9:08	447	172	500	-53	-1.85	1226	+13.56	+13.61	25.32	-47.3	-22.0	
80	9:53	286	172	500	-214	-7.48	1259	+1[illegible].94	+15.23	23.29	-47.3	-24.0	
81	10:16	246	172	499	-253	-8.84	1281	+16.[illegible]	+15.69	23.71	-47.3	-23.6	
82	1[illegible]:28	292	172	499	-207	-7.24	1274	+16.44	+16.55	25.75	-47.3	-21.5	
83	10:40	208	172	49[illegible]	-291	-10.17	1295	+17.70	+17.87	25.40	-47.3	-21.9	
84	1[illegible]:55	165	172	498	-333	-11.65	1296	+17.75	+19.18	25.29	-47.3	-22.0	
85	11:08	136	172	49[illegible]	-362	-12.65	1326	+19.[illegible]	+20.49	27.40	-47.3	-19.9	
86	11:20	170	172	498	-328	-11.46	1313	+18.78	+19.77	27.09	-47.3	-20.2	
87	11:34	171	172	497	-326	-11.40	1324	+19.44	+19.[illegible]3	27.97	-47.3	-19.4	
88	11:48	150	172	497	-347	-12.13	1311	+18.66	+17.[illegible]3	24.56	-47.3	-22.9	
89	12:02	137	172	497	-360	-12.59	1318	+1[illegible].08	+15.98	22.47	-47.3	-24.8	
90	12:12	150	172	496	-346	-12.10	1293	+17.58	+15.60	21.08	-47.3	-26.2	
91	12:27	137	172	496	-359	-12.55	1285	+17.10	+13.97	18.52	-47.3	-28.8	
11	1:10	495	172	495	0								
1	2:12	465	172	493	-28	-0.48	Tie — -0.33 mg						
92	2:35	193	172	492	-309	-10.80	1263	+15.78	+[illegible].98	14.96	-47.3	-32.3	
93	2:45	169	172	491	-322	-11.25	1273	+16.38	+11.35	16.48	-47.3	-30.8	
94	2:58	146	172	491	-345	-12.06	1270	+16.2[illegible]	+12.36	16.50	-47.3	-30.8	
95	3:10	77	172	490	-413	-14.44	1290	+17.[illegible]	+13.95	16.91	-47.3	-30.4	
96	3:30	98	172	489	-391	-13.66	1278	+16.6[illegible]	+15.21	18.23	-47.3	-29.1	
97	3:55	22	172	489	-467	-16.31	1250	+15.46	+16.91	16.08	-47.3	-31.2	
11	3:40	489	172	489	0								

GRAVITY DATA

Project Guyana Range Operator G. A. Durfee Date July 5, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Corrections Elev.	Elev.	Lat.	Cor. g	Base	g
11	9:35	569	172	569	0							
31	10:10	539	172	568	-29	-1.01	Tie — +[illegible].07 mg					
98	10:25	532	172	568	-36	-1.26	1240	+14.[illegible]	+10.05	23.19	-47.3	-24.1
99	10:45	410	172	568	-158	-5.52	1302	+18.12	+[illegible].72	22.32	-47.3	-25.0
100	10:55	556	172	567	-11	-0.38	1246	+14.76	+[illegible].44	22.82	-47.3	-24.5
101	11:13	547	172	567	-20	-0.70	1263	+15.78	+7.33	22.41	-47.3	-24.9
102	11:25	530	172	567	-37	-1.29	1283	+16.98	+6.18	21.87	-47.3	-25.4
103	11:36	548	172	567	-19	-0.66	1269	+16.1[illegible]	+5.03	20.51	-47.3	-26.8
104	11:45	560	172	567	-7	-0.24	1271	+16.26	+4.61	20.63	-47.3	-26.7
105	11:55	565	172	567	-2	-0.07	1258	+15.48	+4.40	19.81	-47.3	-27.5
106	12:08	506	172	566	-60	-2.10	1261	+1[illegible].66	+4.14	17.70	-47.3	-29.6
11	12:23	566	172	566	0							
1	1:36	537	172	565	-29	-1.01	Tie — 0.00 mg					
107	2:03	569	172	566	+3	+0.10	1294	+17.64	+2.19	19.93	-47.3	-[illegible]
108	2:14	708	172	566	+142	+4.96	1248	+14.88	+2.57	22.41	-47.3	-24.9
109	2:28	640	172	566	+74	+2.59	1266	+15.96	+2.43	21.38	-47.3	-25.9
110	2:45	757	172	565	+192	+6.72	1221	+13.26	+3.58	23.56	-47.3	-23.7
111	2:58	461	172	565	-104	-3.63	1311	+1[illegible].66	+4.67	19.70	-47.3	-27.6
112	3:10	394	172	565	-171	-5.98	1314	+1[illegible].84	+5.27	18.13	-47.3	-29.2
113	3:20	393	172	565	-172	-6.02	1278	+16.62	+6.64	17.30	-47.3	-30.0
114	3:35	321	172	565	-244	-8.53	1260	+16.30	+8.07	16.34	-47.3	-31.0
115	3:48	305	172	565	-260	-9.09	1258	+15.48	+8.53	14.92	-47.3	-32.4
7	4:04	366	172	565	-199	-6.96	Tie — -0.04 mg					
11	4:30	565	172	565	0							

GRAVITY DATA

Project Guyana Range Operator G. A. Durfee Date July 18, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Corrections Elev.	Elev.	Lat.	Cor.	g	Base	g
11	7:50	582	173	582	0								
87	8:50	254	173	580	-326		Tie -- 0.00 mg						
209	9:03	227	173	580	-353	-12.34	1345	+20.70	+19.88	28.24	-47.3	-19.0	
210	9:14	304	173	580	-276	-9.64	1344	+20.64	+20.45	31.45	-47.3	-15.8	
211	9:23	482	173	580	-98	-3.42	1257	+15.42	+20.35	32.35	-47.3	-14.9	
212	9:38	292	173	579	-287	-10.03	1337	+20.22	+20.35	30.54	-47.3	-16.8	
213	9:52	387	173	579	-192	-6.70	1254	+15.24	+20.35	28.89	-47.3	-18.4	
214	10:05	325	173	579	-254	-8.88	1252	+15.12	+22.18	28.42	-47.3	-18.9	
215	10:22	241	173	578	-337	-11.76	1256	+15.36	+19.08	22.68	-47.3	-24.6	
216	10:37	584	170	578	+6	-17.94	1250	+15.00	+17.91	14.97	-47.3	-32.4	
217	10:53	466	170	577	-111	-22.02	1256	+15.36	+17.02	10.36	-47.3	-36.9	
218	11:01	434	170	577	-143	-23.15	1252	+15.12	+16.19	8.16	-47.3	-39.1	
219	11:12	376	170	577	-201	-25.17	1250	+15.00	+15.60	5.43	-47.3	-41.9	
208	11:23	335	170	577	-242	-26.61	Tie -- -0.07 mg						
87	11:48	252	173	576	-324								
11	12:30	575	173	575	0								
220	2:00	541	176	574	-33	+17.00	1237	+14.22	-15.56	15.66	-47.3	-31.6	
221	2:15	553	176	574	-21	+17.42	1257	+15.42	-16.85	15.99	-47.3	-31.3	
222	2:28	599	176	574	+25	+19.02	1274	+16.44	-18.20	17.26	-47.3	-30.0	
223	2:45	635	176	574	+61	+20.28	1269	+16.14	-19.49	16.93	-47.3	-30.4	
224	3:00	647	176	574	+73	+20.70	1277	+16.62	-20.78	16.54	-47.3	-30.8	
225	3:13	658	176	574	+84	+21.08	1278	+16.68	-22.05	15.71	-47.3	-31.6	
226	3:25	601	176	573	+28	+19.13	1296	+17.76	-22.37	14.52	-47.3	-32.8	
227	3:45	558	176	573	-15	+17.63	1280	+16.80	-20.78	13.65	-47.3	-33.7	
11	4:18	573	173	573	0								

GRAVITY DATA

Project Cuyuna Range Operator G. A. Durfee Date July 19, 1955

Station	Time	Reading Gm.Dial	Reading Lr.Dial	Base	R	G	Elev.	Corrections Elev.	Corrections Lat.	Cor.	g	Base	g
11	7:40	592	173	592	0								
228	8:18	636	173	580	+56	+1.82	1182	+11.52	-4.77	8.57	-47.3	-38.7
229	8:50	609	173	580	+29	+1.01	1263	+15.78	-[illegible].23	7.56	-47.3	-39.7
230	9:02	607	173	579	+28	+0.98	1257	+15.12	-4.28	7.12	-47.3	-40.2
231	9:13	610	173	578	+32	+1.11	1249	+14.24	-[illegible]	6.77	-47.3	-40.5
232	9:25	598	173	578	+20	+0.70	1249	+1[illegible].94	-3.45	6.39	-47.3	-40.9
11	1:33	568	173	568	0								
11	1:40	593	172	593	0								
233	2:08	422	172	593	-171	-5.98	1246	+14.76	+6.07	14.85	-47.3	-32.5
234	2:21	422	172	593	-171	-5.98	1233	+13.[illegible]	+6.82	14.82	-47.3	-32.5
235	2:33	454	172	593	-139	-4.86	1218	+13.08	+7.79	16.01	-47.3	-31.3
236	2:45	502	172	593	-91	-3.18	1219	+13.14	+9.22	19.18	-47.3	-28.1
237	3:23	436	172	593	-157	-5.49	1215	+12.[illegible]	+7.97	15.38	-47.3	-31.9
238	3:43	474	172	593	-119	-4.16							
11	4:05	593	172	593	0								

GRAVITY DATA

Project Cuyuna Range Operator G. A. Durfee Date July 20, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Corrections Cor. g	Base	G
11	8:00	592	172	592	0							
239	8:25	557	172	592	-35	-1.23	1265	+15.90	+0.90	15.57	-47.3	-31.7
240	8:38	568	172	592	-24	-0.84	1252	+15.12	+0.97	15.25	-47.3	-32.1
241	8:50	547	172	592	-45	-1.57	1278	+16.68	+2.14	17.25	-47.3	-30.1
242	9:05	521	172	592	-71	-2.48	1295	+17.70				
134	9:18	641	172	592	+49		Tie — 0.00 mg					
243	9:35	774	172	592	+182	+6.36	1211	+12.66	-0.41	18.61	-47.3	-28.7
244	9:45	683	172	592	+91	+3.18	1239	+14.34	-0.41	17.11	-47.3	-30.2
245	9:15	457	175	575	-118	+7.98	1208	+12.48	+0.64	21.10	-47.3	-26.2
246	10:18	795	172	593	+202	+7.06	1208	+12.48	-1.98	17.56	-47.3	-29.7
247	12:55	472	175	576	-104	+8.53	1213	+12.78	-2.04	19.27	-47.3	-28.0
248	10:56	547	172	593	-46	-1.61	1256	+15.36	+2.86	16.61	-47.3	-30.7
249	11:05	528	172	593	-65	-2.27	1279	+16.74	+3.34	17.81	-47.3	-29.5
250	11:15	437	172	593	-156	-5.45	1282	+16.92	+4.23	15.70	-47.3	-31.6
251	11:28	466	172	593	-127	-4.44	1283	+16.98	+3.58	16.12	-47.3	-31.2
252	11:37	610	172	593	+17	+0.59	1218	+13.08	+2.60	16.27	-47.3	-31.0
11	11:50	593	172	593	0							
11	11:54	577	173	577	0							
253	1:10	503	175	576	-73	+9.55	1213	+12.78	-1.93	20.40	-47.3	-26.9
254	1:19	498	175	576	-78	+9.37	1209	+12.54	-2.50	19.41	-47.3	-27.9
255	1:43	436	175	576	-140	+7.21	1201	+12.06	-3.98	15.29	-47.3	-32.0
256	1:55	441	175	576	-135	+7.38	1197	+11.82	-4.33	14.87	-47.3	-32.4
257	2:08	467	175	575	-108	+8.33	1200	+12.00	-5.31	15.02	-47.3	-32.3
258	2:25	421	175	575	-154	+6.72	1202	+12.12	-4.35	14.49	-47.3	-32.8
259	2:42	421	175	575	-154	+6.72	1195	+11.70	-4.32	14.10	-47.3	-33.2
129	2:55	402	175	575	-173	+6.06	Tie — 0.24 mg					
260	3:30	378	175	574	-196	+5.25	1234	+14.04	+1.62	20.91	-47.3	-25.4
261	3:37	299	175	574	-275	+2.50	1236	+14.16	+2.26	18.92	-47.3	-28.4
11	4:00	574	173	574	0							

GRAVITY DATA

Project Ogden Range Operator G. A. Durfee Date July 21, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Corrections Elev.	Elev.	Lat.	Cor.	g	Base	g
11	8:25	580	173	580	0								
262	9:25	739	173	581	+158	+5.52	1258	+15.40	-11.65	3.35	-47.3	-37.9
263	9:37	752	173	581	+171	+5.98	1262	+15.72	-11.65	10.05	-47.3	-37.3
264	9:50	759	173	582	+177	+6.18	1268	+16.08	-12.47	9.79	-47.3	-37.5
265	10:10	386	177	582	-196	+17.34	1225	+13.50	-15.10	15.74	-47.3	-31.6
266	10:33	341	177	583	-242	+15.74	1229	+17.34	-15.85	17.23	-47.3	-30.1
267	10:45	393	177	583	-190	+17.56	1243	+14.58	-15.29	16.05	-47.3	-31.5
268	10:58	319	177	583	-264	+14.98	1260	+15.60	-15.29	15.29	-47.3	-32.0
269	11:16	281	177	583	-302	+13.64	1267	+16.02	-13.28	16.38	-47.3	-30.9
270	11:28	544	175	584	-40	+10.70	1262	+15.72	-12.36	14.06	-47.3	-33.3
271	11:53	690	174	584	+106	+9.75	1272	+16.32	-12.51	13.46	-47.3	-33.8
143	12:07	600	174	584	+16		Tie — -0.02 mg						
11	12:40	585	173	585	0								
272	1:58	637	173	584	+53	+1.85	1218	+13.08	-5.63	9.30	-47.3	-38.0
273	2:09	629	173	584	+45	+1.57	1198	+11.98	-6.42	7.03	-47.3	-40.3
274	2:20	533	173	584	-51	-1.78	1234	+14.34	-6.51	5.75	-47.3	-42.5
275	2:29	557	173	584	-27	-0.94	1219	+13.14	-5.90	6.30	-47.3	-41.0
276	2:38	576	173	584	-8	-0.28	1220	+13.20	-5.28	7.64	-47.3	-39.7
277	2:55	561	173	584	-23	-0.80	1206	+12.36	-3.57	7.99	-47.3	-39.3
278	3:08	556	173	584	-28	-0.98	1196	+11.76	-1.93	8.85	-47.3	-38.5
279	3:26	444	173	584	-140	-4.88	1227	+13.62	-0.75	7.99	-47.3	-39.3
280	3:35	433	173	583	-150	-5.24	1219	+13.14	0.00	7.90	-47.3	-39.4
185	3:55	373	173	583	-210		Tie — -0.07 mg						
11	4:30	583	173	583	0								

GRAVITY DATA

Project Cayuna Range Operator G. A. Durfee Date July 22, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Cor.	C	Base	g
11	7:55	593	173	593	0								
281	8:55	737	173	594	+143	+5.00	1216	+12.96	-10.80	7.16		-47.3	-40.1
282	9:10	754	173	594	+160	+5.60	1214	+12.94	-11.72	6.72		-47.3	-40.6
283	9:23	759	173	594	+165	+5.77	1215	+12.99	-11.96	6.71		-47.3	-40.6
284	9:40	730	173	595	+135	+4.72	1239	+14.34	-13.01	6.05		-47.3	-41.3
285	9:58	455	175	595	-140	+7.20	1231	+13.65	-14.47	6.59		-47.3	-40.7
286	10:10	418	175	595	-177	+5.91	1225	+13.50	-14.00	5.41		-47.3	-41.9
287	10:35	664	175	595	+69	+14.51	1299	+17.24	-20.75	11.70		-47.3	-35.6
225	11:20	680	176	596	+84		Tie -- 0.00 mg						
288	11:33	694	176	596	+98	+21.57	1282	+16.92	-22.10	16.39		-47.3	-30.9
11	12:20	597	173	597	0								
289	2:35	735	173	597	+138	+4.83	1272	+16.32	-13.01	8.14		-47.3	-39.2
11	4:21	597	173	597	0								

GRAVITY DATA

Project Guyuna Range Operator G. A. Durfee Date August 1, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Cor.	g	Base	g
11	11:00	389	175	389	0								
290	11:40	337	175	389	-52	-1.82	1191	+11.46	+10.74	20.38		-47.3	-26.9
291	11:50	350	175	389	-39	-1.36	1187	+11.22	+10.38	20.24		-47.3	-27.1
292	12:05	283	175	389	-106	-3.70	1206	+12.36	+10.01	18.67		-47.3	-28.6
293	12:30	277	175	389	-112	-3.91	1197	+11.82					
294	2:15	207	175	390	-183	-6.40	1193	+11.58	+6.74	11.92		-47.3	-35.4
237	2:30	235	175	390	-155		Tie — -0.37 mg						
11	4:25	390	175	390	0								

GRAVITY DATA

Project Cayuna Range | Operator G. A. Durfee | Date August 2, 1955

Station	Time	Reading Sm. Dial	Reading Lg. Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Cor. g	Base	g
11	9:35	406	175	406	0							
290	10:03	356	175	406	-50	-1.75	Tie —	+0.07 mg				
295	10:23	371	175	406	-35	-1.22	1243	+14.58	+15.25	28.61	-47.3	-18.7
297	10:30	339	175	406	-67	-2.34	1252	+15.12	+15.39	28.87	-47.3	-18.4
298	10:37	352	175	406	-54	-1.89	1236	+14.16	+16.60	28.87	-47.3	-18.4
299	10:45	241	175	406	-165	-5.76	1254	+15.24	+17.91	27.39	-47.3	-19.9
300	10:50	194	175	406	-212	-7.41	1257	+15.42	+17.23	27.24	-47.3	-20.1
301	11:08	219	175	406	-187	-6.54	1248	+14.88	+20.55	28.89	-47.3	-18.4
302	11:15	198	175	407	-209	-7.30	1264	+15.84	+20.55	29.09	-47.3	-18.2
303	11:25	256	175	407	-151	-5.28	1219	+13.14	+21.83	29.69	-47.3	-17.6
304	11:40	182	175	407	-225	-7.87	1241	+14.46	+21.83	28.42	-47.3	-18.9
305	11:48	193	175	407	-214	-7.46	1231	+13.86	+20.50	26.88	-47.3	-20.4
306	11:56	299	175	407	-108	-3.77	1227	+13.62	+19.21	29.06	-47.3	-18.2
307	12:05	362	175	407	-45	-1.57	1220	+13.20	+17.57	29.20	-47.3	-18.1
308	12:15	378	175	407	-29	-1.01	1221	+13.26	+16.60	28.85	-47.3	-18.5
309	12:20	338	175	407	-69	-2.41	1238	+13.68	+15.25	26.52	-47.3	-20.8
11	1:00	407	175	407	0							

GRAVITY DATA

Project Duruna Range Operator G. A. Durfee Date August 3, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Reading Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Corrections Cor. g	Base	g
11	8:00	427	175	427	0							
Gr.Rapids	9:45	468	182	427	+41	+43.77	1298	+17.9	-[illegible].1	-7.4	-47.3	-54
11	11:48	427	175	427	0							
Brainerd	2:07	328	175	427	-99	-3.46	1205	+12.30	+13.15	21.99	-47.3	-25.3
310	2:20	335	175	427	-92	-3.21	1201	+12.06	+11.20	20.05	-47.3	-27.3
311	2:30	338	175	427	-89	-3.11	1199	+11.94	+10.45	19.28	-47.3	-28.0
312	2:40	277	175	427	-150	-5.24	1211	+12.66	+9.37	16.79	-47.3	-30.5
313	2:50	207	175	427	-220	-7.70	1229	+13.74	+8.34	14.38	-47.3	-32.9
314	3:00	263	175	427	-164	-5.73	1202	+12.12	+7.27	13.66	-47.3	-33.6
315	3:25	265	175	428	-163	-5.70	1215	+12.90	+6.56	13.76	-47.3	-33.5
316	3:45	354	175	428	-74	-2.59	1204	+12.24	+12.46	22.11	-47.3	-25.2
317	3:50	426	175	428	-2	-0.07	1223	+13.38	+12.71	26.02	-47.3	-21.3
318	3:56	420	175	428	-8	-0.28	1258	+15.48	+12.67	27.87	-47.3	-19.4
319	4:02	320	175	428	-108	-3.77	1229	+13.74	+11.73	21.70	-47.3	-25.6
11	4:25	428	175	428	0							

GRAVITY DATA

Project Guyana Range Operator G. A. Durfee Date August 4, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	Δ	g	Corrections Elev.	Elev.	Lat.	Cor.	g	Base	g
11	11:10	439	175	439	0								
287	11:59	505	177	432	+66		Tie — +6.11 mg						
11	12:23	438	175	438	0								
320	2:14	271	175	439	-168	-5.88	1220	+13.20	+5.93	13.25	-47.3	-31.1	
321	2:30	261	175	440	-179	-6.26	1213	+12.78	+7.28	11.80	-47.3	-35.5	
322	2:42	241	175	440	-199	-6.96	1212	+12.72	+7.91	13.67	-47.3	-33.6	
323	3:00	332	175	440	-108	-3.78	1209	+12.54	+9.65	18.41	-47.3	-28.9	
324	3:06	332	175	440	-108	-3.78	1210	+12.60	+10.49	19.31	-47.3	-28.0	
325	3:16	392	175	440	-48	-1.68	1182	+10.92	+11.30	21.04	-47.3	-26.3	
326	3:24	381	175	440	-59	-2.06	1204	+12.24	+12.07	23.05	-47.3	-24.3	
316	3:47	360	175	441	-81		Tie — 0.08 mg						
11	4:11	441	175	441	0								

GRAVITY DATA

Project Cayuna Range Operator G. A. Durfee Date August 5, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Corrections Cor.	g	Base	g
11	8:24	460	175	468	0								
11	11:55	471	175	471	0								
327	12:31	396	177	471	-75	+9.48	1200	+12.00	+7.71	17.19		-47.3	-30.1
328	12:38	391	177	471	-80	+9.30	1205	+12.30	-5.63	15.97		-47.3	-31.3
329	12:54	435	177	472	-37	+10.81	1203	+12.18	-7.92	16.07		-47.3	-31.2
330	1:03	440	177	472	-32	+10.98	1205	+12.30	-6.93	16.35		-47.3	-30.9
331	1:13	488	177	472	+16	+12.66	1204	+12.24	-8.52	16.38		-47.3	-30.9
332	1:46	464	177	472	-8	+11.82	1210	+12.60	-3.61	20.81		-47.3	-26.5
333	2:00	493	177	472	+21	+12.83	1199	+11.94	-4.31	20.46		-47.3	-26.8
334	2:07	477	177	472	+5	+12.27	1201	+12.06	-5.60	18.73		-47.3	-28.6
335	2:15	481	177	472	+9	+12.41	1197	+11.82	-6.91	17.32		-47.3	-30.0
336	2:26	570	177	473	+97	+15.49	1204	+12.24	-6.91	20.82		-47.3	-26.5
337	2:35	570	177	473	+97	+15.49	1199	+11.94	-7.87	19.56		-47.3	-27.7
338	2:49	563	177	473	+90	+15.24	1205	+12.30	-9.18	18.36		-47.3	-28.9
339	2:58	565	177	473	+92	+15.32	1209	+12.54	-10.43	17.43		-47.3	-29.9
340	3:08	592	177	473	+119	+16.26	1206	+12.36	-12.42	16.20		-47.3	-31.1
341	3:16	563	177	473	+90	+15.24	1203	+12.18	-14.00	13.42		-47.3	-33.9
76	4:28	525	175	474	+51		Tie —	0.14 mg					
11	4:45	474	175	474	0								

GRAVITY DATA

Project Cuyuna Range Operator G. A. Durfee Date August 8, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	G	Elev.	Corrections Elev.	Corrections Lat.	Corrections Cor.	G	Base	G
11	8:00	517	175	517	0								
342	9:30	440	178	520	-80	+15.25	1236	+14.16	-11.80	17.61	-47.3	-29.7
343	9:40	496	178	521	-25	+17.28	1219	+13.44	-12.42	18.00	-47.3	-29.3
344	9:50	568	178	521	+47	+19.79	1222	+13.32	-13.75	19.36	-47.3	-27.9
345	10:08	522	178	521	+1	+18.19	1219	+13.44	-15.07	16.26	-47.3	-31.0
346	10:20	458	178	522	-64	+15.91	1216	+12.96	-15.07	13.80	-47.3	-33.5
347	10:38	528	178	522	+6	+18.36	1221	+13.26	-15.07	16.55	-47.3	-30.7
348	10:52	602	178	523	+79	+20.91	1220	+13.20	-15.05	19.06	-47.3	-28.2
349	11:02	539	178	523	+16	+18.71	1219	+13.44	-16.32	15.53	-47.3	-31.8
350	11:10	524	178	524	0	+18.15	1215	+12.98	-17.61	13.44	-47.3	-33.9
351	11:47	472	178	525	-53	+16.30	1228	+13.68	-17.50	12.48	-47.3	-34.8
352	11:56	497	178	525	-28	+17.17	1213	+12.78	-16.29	12.96	-47.3	-34.3
353	12:03	491	178	526	-35	+16.93	1216	+12.96	-16.49	13.40	-47.3	-33.9
354	12:12	486	178	526	-40	+16.75	1219	+13.14	-16.43	13.46	-47.3	-33.8
355	12:19	454	178	526	-72	+15.63	1218	+13.08	-15.57	13.14	-47.3	-34.2
342	12:41	447	178	526	-79								
327	1:37	277	178	526	-249		Tie — +0.07 mg						
356	2:17	436	178	526	-90	+15.00	1199	+11.94	-9.43	17.51	-47.3	-29.8
357	2:30	466	178	527	-61	+16.02	1209	+12.54	-12.48	16.08	-47.3	-31.2
358	2:40	497	178	527	-30	+17.10	1245	+12.30	-11.17	18.23	-47.3	-29.1
359	2:58	423	178	527	-104	+14.52	1203	+12.18	-13.77	12.93	-47.3	-34.4
360	3:04	499	178	527	-28	+17.17	1209	+12.54	-15.50	14.21	-47.3	-33.1
361	3:11	515	178	527	-12	+17.73	1271	+16.26	-16.80	17.19	-47.3	-30.1
362	3:21	533	178	527	+6	+18.36	1222	+13.32	-14.47	13.21	-47.3	-34.1
363	3:46	470	178	527	-57	+16.16	1227	+13.62	-9.81	19.97	-47.3	-27.3
342	3:51	448	178	527	-79								
11	4:37	527	175	527	0								

GRAVITY DATA

Project Cayuna Range Operator G. A. Durfee Date August 9, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Corrections Cor. g	Base	g
11	8:03	549	175	549	0							
342	9:43	472	178	549	-77							
365	10:13	551	178	551	+1	+18.18	1211	+12.66	-17.48	13.36	-47.3	-33.9
366	10:16	550	178	550	0	+18.15	1223	+13.38	-18.94	12.59	-47.3	-34.7
367	10:30	572	178	550	+22	+18.92	1227	+13.62	-18.95	13.59	-47.3	-33.7
368	10:38	626	178	550	+76	+20.80	1214	+12.74	-18.94	14.70	-47.3	-32.6
369	10:45	597	178	550	+47	+19.79	1222	+13.32	-18.92	14.19	-47.3	-33.1
370	10:55	629	178	550	+79	+20.91	1225	+13.50	-20.21	14.20	-47.3	-33.1
371	11:04	610	178	550	+60	+20.25	1235	+14.10	-21.18	13.17	-47.3	-34.1
372	11:26	541	178	550	-9	+17.84	1223	+13.38	-20.21	11.01	-47.3	-36.3
373	11:34	545	178	550	-5	+17.98	1214	+14.04	-21.58	11.04	-47.3	-36.3
342	12:10	473	178	551	-78							
364	12:39	343	178	551	-208		Tie —	0.03 mg				
374	1:33	341	178	551	-210	+10.81	1206	+12.36	-6.93	16.24	-47.3	-31.1
375	1:40	326	178	551	-225	+10.27	1200	+12.00	-6.93	15.34	-47.3	-32.0
376	2:09	313	178	552	-239	+9.79	1209	+12.54	-6.95	15.38	-47.3	-31.9
377	2:20	269	178	552	-283	+8.25	1205	+12.30	-5.66	14.89	-47.3	-32.4
378	2:33	579	178	552	+27	+19.09	1226	+13.56	-13.82	18.83	-47.3	-28.5
379	3:04	540	178	552	-12	+17.73	1223	+13.38	-13.29	17.82	-47.3	-29.5
380	3:15	471	178	552	-81	+15.32	1256	+14.36	-12.48	18.20	-47.3	-29.1
381	3:22	446	178	552	-106	+14.45	1217	+13.02	-11.20	16.27	-47.3	-31.0
382	3:30	382	178	552	-170	+12.20	1221	+13.26	-9.89	15.57	-47.3	-31.7
383	3:38	334	178	552	-218	+10.53	1208	+12.48	-8.41	14.40	-47.3	-32.9
384	3:50	417	178	552	-135	+13.41	1203	+12.18	-8.56	17.03	-47.3	-30.3
342	4:37	474	178	553	-79							
11	5:26	553	175	553	0							

GRAVITY DATA

Project Cuyuna Range Operator G. A. Durfee Date August 10, 1955

Station	Time	Readings Sm.Dial	Lg.Dial	Baro	H	g	Corrections Elev.	Elev.	Lat.	Cor.	g	Base	g
11	7:50	573	175	573	0								
364	8:51	367	178	574	-207		Tie — 0.22 mg						
385	9:12	546	178	575	-29	+17.04	1237	+14.22	-18.94	12.32	-47.3	-35.0	
386	9:22	549	178	575	-26	+17.24	1222	+14.32	-17.65	12.91	-47.3	-34.4	
387	9:31	588	178	575	+13	+18.60	1211	+12.76	-18.93	12.33	-47.3	-35.0	
388	9:40	536	178	575	-39	+16.79	1246	+14.76	-18.93	12.62	-47.3	-34.7	
389	9:59	597	178	575	+22	+18.92	1239	+14.34	-20.24	13.02	-47.3	-34.3	
390	10:10	620	178	576	+44	+19.69	1233	+13.94	-21.55	12.12	-47.3	-35.2	
391	10:23	647	178	576	+71	+20.63	1247	+14.32	-20.55	14.90	-47.3	-32.4	
392	10:33	606	178	576	+30	+19.20	1228	+13.68	-13.68	13.93	-47.3	-33.4	
393	10:46	617	178	576	+41	+19.58	1287	+17.22	-20.26	16.54	-47.3	-30.8	
394	10:55	599	178	577	+22	+18.92	1316	+18.96	-20.26	17.62	-47.3	-29.7	
395	11:06	653	178	577	+76	+20.80	1296	+17.76	-21.35	17.21	-47.3	-30.1	
362	11:32	585	178	577	+8		Tie — 0.07 mg						
364	12:10	371	178	578	-207								
396	1:04	517	178	579	-62	+15.98	1206	+12.36	-9.80	18.54	-47.3	-28.8	
397	1:13	525	178	579	-54	+16.26	1216	+12.96	-9.80	19.42	-47.3	-27.9	
398	1:28	476	178	579	-103	+14.55	1214	+12.84	-7.95	20.44	-47.3	-26.9	
399	1:39	579	178	579	0	+18.15	1214	+12.84	-7.02	23.97	-47.3	-23.4	
400	1:48	600	178	579	+21	+18.88	1214	+12.84	-7.08	24.64	-47.3	-22.7	
401	1:56	619	178	579	+40	+19.55	1216	+12.96	-7.08	25.43	-47.3	-21.9	
402	2:20	594	178	579	+15	+18.67	1216	+12.96	-9.00	23.63	-47.3	-23.7	
403	2:37	508	178	578	-70	+15.70	1223	+13.38	-5.71	23.37	-47.3	-23.9	
404	2:51	389	178	578	-189	+11.55	1220	+13.20	-4.43	20.32	-47.3	-27.0	
405	3:03	117	178	578	-461	+2.05	1244	+14.64	-3.10	13.59	-47.3	-33.7	
364	4:09	370	178	578	-208								
11	4:36	578	178	578	0								

GRAVITY DATA

Project Guyuna Range Operator G. A. Durfee Date August 11, 1955

Station	Time	Reading Sm.Dial	Lg.Dial	Base	C	g	Elev.	Corrections Elev.	Lat.	Cor.	g	Base	g
11	7:51	582	175	582	0								
405	9:01	644	175	585	+59		Tie —	0.02 mg					
406	9:08	634	175	586	+48	+1.68	1230	+13.00	-1.80	13.60	-47.3	-33.6	
407	9:20	589	175	586	+3	+0.11	1226	+13.56	-0.52	13.15	-47.3	-34.1	
408	9:30	512	175	587	-75	-2.62	1257	+15.42	+0.89	13.69	-47.3	-33.6	
409	9:39	519	175	587	-68	-2.38	1268	+16.08	+2.20	15.90	-47.3	-31.4	
410	9:52	471	175	588	-117	-4.09	1296	+17.76	+3.51	17.18	-47.3	-30.1	
411	10:02	523	175	588	-65	-2.27	1260	+15.60	+4.84	18.17	-47.3	-29.1	
412	10:11	505	175	588	-83	-2.90	1267	+16.02	+6.16	19.28	-47.3	-28.0	
413	10:20	439	175	589	-150	-5.24	1264	+15.84	+7.44	18.04	-47.3	-29.3	
414	11:15	420	175	591	-171	-5.98	1257	+15.42	+8.73	18.17	-47.3	-29.1	
415	11:30	342	175	592	-250	-8.74	1258	+15.48	+10.01	16.75	-47.3	-30.5	
416	11:40	402	175	592	-190	-6.64	1246	+14.76	+11.28	20.10	-47.3	-27.2	
11	12:36	595	175	595	0								
405	2:03	647	175	592	+55		Tie —	0.14 mg					
406	2:10	636	175	591	+45		Tie —	0.10 mg					
417	2:24	612	175	591	+21	+0.73	1254	+15.24	-3.19	12.78	-47.3	-34.5	
418	2:32	617	175	592	+26	+0.91	1254	+15.24	-1.84	14.31	-47.3	-33.0	
419	2:44	598	175	591	+8	+0.28	1242	+14.52	-0.53	14.27	-47.3	-33.0	
420	2:54	616	175	590	+26	+0.91	1243	+14.58	+0.89	16.38	-47.3	-30.9	
421	3:02	560	175	589	-29	-1.01	1256	+15.36	+2.87	17.22	-47.3	-30.1	
422	3:15	545	175	589	-44	-1.54	1324	+19.44	+3.76	21.66	-47.3	-25.6	
423	3:23	554	175	589	-35	-1.22	1290	+17.40	+5.02	21.20	-47.3	-26.1	
424	3:30	442	175	588	-146	-5.10	1294	+17.64	+6.05	18.59	-47.3	-28.7	
425	3:38	506	175	588	-82	-2.87	1299	+17.94	+7.36	22.43	-47.3	-24.9	
11	4:31	586	175	586	0								

GRAVITY DATA

Project Owyhee Range Operator G. A. Durfee Date August 10, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	N	g	Corrections Elev.	Elev.	Lat.	Cor. g	Base	g
11	7:50	573	175	573	0							
364	8:51	367	178	574	-207		Tie — 0.00 mg					
385	9:12	546	178	575	-29	+17.04	1237	+14.22	-18.54	12.32	-47.3	-35.0
386	9:22	549	178	575	-26	+17.24	1222	+14.32	-17.65	12.91	-47.3	-34.4
387	9:41	588	178	575	+13	+18.60	1211	+12.76	-18.93	12.33	-47.3	-35.0
388	9:40	536	178	575	-39	+16.79	1246	+14.76	-18.93	12.62	-47.3	-34.7
389	9:59	597	178	575	+22	+18.92	1239	+14.34	-20.24	13.02	-47.3	-34.3
390	10:10	620	178	576	+44	+19.69	1233	+13.94	-21.55	12.12	-47.3	-35.2
391	10:23	647	178	576	+71	+20.63	1247	+14.32	-20.55	14.90	-47.3	-32.4
392	10:33	606	178	576	+30	+19.20	1228	+13.68	-13.62	13.93	-47.3	-33.4
393	10:46	617	178	576	+41	+19.58	1287	+17.22	-20.26	16.54	-47.3	-30.8
394	10:55	599	178	577	+22	+18.92	1316	+18.96	-20.26	17.62	-47.3	-29.7
395	11:06	653	178	577	+76	+20.80	1296	+17.76	-21.35	17.21	-47.3	-30.1
362	11:32	585	178	577	+8		Tie — 0.07 mg					
364	12:10	371	178	578	-207							
396	1:04	517	178	579	-62	+15.98	1206	+12.36	-9.80	18.54	-47.3	-28.8
397	1:13	525	178	579	-54	+16.26	1216	+12.96	-9.80	19.42	-47.3	-27.9
398	1:28	476	178	579	-103	+14.55	1214	+12.84	-7.95	20.44	-47.3	-26.9
399	1:39	579	178	579	0	+18.15	1214	+12.84	-7.02	23.97	-47.3	-23.4
400	1:40	600	178	579	+21	+18.88	1214	+12.84	-7.08	24.64	-47.3	-22.7
401	1:56	619	178	579	+40	+19.55	1216	+12.96	-7.08	25.43	-47.3	-21.9
402	2:20	594	178	579	+15	+18.67	1216	+12.96	-9.00	23.63	-47.3	-23.7
403	2:37	508	178	578	-70	+15.70	1223	+13.38	-5.71	23.37	-47.3	-23.9
404	2:51	389	178	578	-189	+11.55	1220	+13.20	-4.43	20.32	-47.3	-27.0
405	3:03	117	178	578	-461	+2.05	1244	+14.64	-3.10	13.59	-47.3	-33.7
364	4:09	370	178	578	-208							
11	4:36	578	178	578	0							

GRAVITY DATA

Project Guyuna Range Operator G. A. Durfee Date August 11, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	Δ	g	Elev.	Corrections Elev.	Corrections Lat.	Corrections Cor.	g	Base	g
11	7:51	592	175	592	0								
405	9:01	644	175	595	+59		Tie --	0.02 mg					
406	9:08	634	175	586	+48	+1.68	1230	+13.00	-1.80	13.68	-47.3	-33.6	
407	9:20	589	175	586	+3	+0.11	1226	+13.56	-0.52	13.15	-47.3	-34.1	
408	9:30	512	175	587	-75	-2.62	1257	+15.42	+0.89	13.69	-47.3	-33.6	
409	9:39	519	175	587	-68	-2.38	1268	+16.03	+2.20	15.90	-47.3	-31.4	
410	9:52	471	175	588	-117	-4.09	1296	+17.76	+3.51	17.18	-47.3	-30.1	
411	10:02	523	175	588	-65	-2.27	1260	+15.60	+4.04	18.17	-47.3	-29.1	
412	10:11	505	175	588	-83	-2.90	1267	+16.02	+6.16	19.28	-47.3	-28.0	
413	10:20	439	175	589	-150	-5.24	1264	+15.84	+7.44	18.04	-47.3	-29.3	
414	11:15	420	175	591	-171	-5.98	1257	+15.42	+8.73	18.17	-47.3	-29.1	
415	11:30	342	175	592	-250	-8.74	1258	+15.48	+10.01	16.75	-47.3	-30.5	
416	11:40	402	175	592	-190	-6.64	1246	+14.76	+11.98	20.10	-47.3	-27.2	
11	12:36	595	175	595	0								
405	2:03	647	175	592	+55		Tie --	0.14 mg					
406	2:10	636	175	591	+45		Tie --	0.10 mg					
417	2:24	612	175	591	+21	+0.73	1254	+15.24	-3.19	12.78	-47.3	-34.5	
418	2:32	617	175	592	+26	+0.91	1254	+15.24	-1.84	14.31	-47.3	-33.0	
419	2:44	598	175	591	+8	+0.28	1242	+14.52	-0.53	14.27	-47.3	-33.0	
420	2:54	616	175	590	+26	+0.91	1243	+14.58	+0.89	16.38	-47.3	-30.9	
421	3:02	560	175	589	-29	-1.01	1256	+15.36	+2.87	17.22	-47.3	-30.1	
422	3:15	545	175	589	-44	-1.54	1324	+19.44	+3.76	21.66	-47.3	-25.6	
423	3:23	554	175	589	-35	-1.22	1290	+17.40	+5.02	21.20	-47.3	-26.1	
424	3:30	442	175	588	-146	-5.10	1294	+17.64	+6.05	18.59	-47.3	-28.7	
425	3:38	506	175	588	-82	-2.87	1299	+17.94	+7.36	22.43	-47.3	-24.9	
11	4:31	586	175	586	0								

GRAVITY DATA

Project Sprung Range Operator G. A. Durfee Date August 15, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Corrections Elev.	Elev.	Lat.	Cor. g	Base	g
			174									
364	8:36	594	177	801	-207							
425	9:08	203	177	801	-598	-2.75	Tie — -0.12 mg					
426	9:15	264	177	801	-537	-0.61	1286	+17.16	+8.37	24.92	-47.3	-22.4
427	9:25	284	177	801	-517	-0.10	1273	+16.38	+9.65	25.93	-47.3	-21.4
428	9:32	281	177	801	-520	-0.02	1263	+15.78	+10.98	26.74	-47.3	-20.6
429	9:40	260	177	801	-541	-0.75	1261	+15.66	+12.33	27.24	-47.3	-20.1
430	9:49	213	177	801	-588	-2.41	1252	+15.12	+13.63	26.34	-47.3	-21.1
431	9:59	151	177	801	-650	-4.55	1267	+16.02	+14.92	26.39	-47.3	-20.9
432	10:18	165	177	801	-636	-4.07	1273	+16.38	+8.66	20.97	-47.3	-26.4
433	10:27	143	177	801	-658	-4.85	1276	+16.56	+7.36	19.07	-47.3	-28.2
364	11:01	594	177	801	-207							
434	11:15	571	177	801	-230	+10.11	1230	+13.80	+2.70	26.61	-47.3	-20.7
435	11:23	618	177	801	-183	+11.75	1233	+13.98	+3.09	28.82	-47.3	-18.5
436	11:30	556	177	801	-245	+9.58	1218	+13.08	+3.09	25.75	-47.3	-21.5
437	11:37	464	177	802	-338	+6.33	1227	+13.62	+3.09	23.04	-47.3	-24.3
405	11:47	339	177	802	-463		Tie — +0.07 mg					
438	12:00	325	177	802	-477	+1.47	1230	+13.80	-1.75	13.52	-47.3	-33.8
439	12:08	251	177	802	-551	-1.10	1257	+15.42	-0.96	14.26	-47.3	-33.0
440	12:17	248	177	802	-554	-1.21	1260	+15.60	-0.67	13.72	-47.3	-33.6
441	12:25	453	177	802	-349	+5.95	1225	+13.50	-1.74	17.71	-47.3	-29.6
442	12:33	450	177	802	-352	+5.85	1263	+15.78	-1.68	19.95	-47.3	-27.3
364	1:20	596	177	803	-207							
443	1:33	374	177	803	-429	+3.15	1251	+15.06	-3.67	14.54	-47.3	-32.8
444	1:45	167	177	803	-636	-4.07	1257	+15.42	+0.64	11.99	-47.3	-35.3
445	1:52	103	177	804	-701	-6.35	1268	+17.28	+1.42	12.35	-47.3	-34.9
446	2:02	205	177	804	-599	-2.77	1249	+14.94	+1.80	13.97	-47.3	-33.3
447	2:10	246	177	804	-558	-1.35	1230	+13.80	+3.45	15.90	-47.3	-31.4
448	2:18	118	177	804	-686	-5.83	1274	+16.44	+4.25	14.86	-47.3	-32.4
449	2:27	124	177	804	-680	-5.53	1272	+16.32	+4.89	15.68	-47.3	-31.6
450	2:35	80	177	804	-724	-7.15	1261	+15.66	+6.18	14.69	-47.3	-32.6

GRAVITY DATA

Project Guyana Range Operator G. A. Durfee Date August 15, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Cor.	g	Base	g
451	2:44	Off Scale											
452		Off Scale											
453	3:12	44	177	805	-761	-8.45	1292	+17.52	+2.25	11.32		-47.3	-36.0
454	3:29	524	177	805	-281	+8.33	1238	+14.28	-1.67	20.94		-47.3	-26.4
455	3:40	389	177	806	-417	+3.57	1238	+14.28	-0.37	17.48		-47.3	-29.8
456	3:47	285	177	806	-521	-0.05	1248	+14.08	+0.93	15.76		-47.3	-31.5
364	4:01	599	177	806	-207								

GRAVITY DATA

Project Ogguna Range Operator G. A. Durfee Date August 16, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	%	g	Elev.	Corrections Elev.	Corrections Lab.	Corr. g	Base	g
			174									
364	9:23	596	177	803	-207							
457	9:45	515	175	803	-288	-4.02	1256	+15.36	+2.23	13.57	-47.3	-33.7
458	9:52	422	175	803	-381	-7.27	1288	+17.22	+3.54	13.55	-47.3	-33.7
459	10:02	410	175	803	-393	-7.69	1264	+1[illegible]	+5.28	13.43	-47.3	-33.9
460	10:09	366	175	803	-437	-9.21	1264	+15.[illegible]	+6.11	12.74	-47.3	-34.6
461	10:19	270	175	804	-534	-12.61	1268	+16.08	+7.27	10.74	-47.3	-36.6
462	10:27	128	175	804	-682	-17.77	1265	+15.90	+8.75	6.88	-47.3	-40.4
463	10:39	313	173	804	-491	-23.21	1264	+15.84	+9.40	2.03	-47.3	-45.3
464	10:[illegible]	231	173	805	-574	-26.11	1293	+17.55	+9.56	1.03	-47.3	-46.3
186	11:08	289	175	805	-516	-11.98	Tie -- +1.08 mg					
465	11:26	380	175	805	-425	-8.05	1274	+16.44	+5.12	13.51	-47.3	-33.8
364	12:14	590	177	805	-207							
466	12:58	616	174	805	-189	-6.61	1239	+14.34	+3.52	11.25	-47.3	-36.1
467	1:08	401	174	806	-405	-14.15	1279	+16.74	+4.80	7.39	-47.3	-39.9
452	1:1[illegible]	388	174	806	-418	-14.61	1261	+1[illegible]	+6.11	7.16	-47.3	-40.1
451	1:27	489	174	806	-317	-11.09	1258	+15.48	+7.44	11.83	-47.3	-35.5
468	1:35	352	174	806	-454	-15.86	1257	+15.43	+8.72	8.28	-47.3	-39.0
469	1:45	253	174	806	-553	-19.31	1240	+14.10	+10.02	5.11	-47.3	-42.2
470	1:54	225	174	806	-581	-20.30	1291	+17.4[illegible]	+11.32	8.48	-47.3	-38.8
471	2:01	344	174	807	-463	-16.17	1271	+16.26	+12.32	12.41	-47.3	-34.9
472	2:1[illegible]	372	172	807	-435	-27.30			+13.12			
473	2:21	334	172	807	-473	-28.63			+13.70			
474	2:33	468	172	807	-339	-23.95			+12.90			
475	3:29	639	170	808	-169	+18.30	1220	+13.20	-[illegible].07	24.43	-47.3	-22.9
476	3:39	575	178	809	-234	+16.02	1218	+13.08	-6.30	22.80	-47.3	-24.5
364	4:06	602	177	809	-207							

GRAVITY DATA

Project Oquirrh Range Operator G. A. Durfee Date August 15, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Cor.	g	Base	g
451	2:44	Off Scale											
452		Off Scale											
453	3:12	44	177	805	-761	-8.45	1292	+17.22	+2.25	11.32	-47.3	-36.0
454	3:29	524	177	805	-281	+8.33	1238	+14.28	-1.67	20.94	-47.3	-26.4
455	3:40	389	177	806	-417	+3.57	1238	+14.28	-0.37	17.48	-47.3	-29.8
456	3:47	285	177	806	-521	-0.05	1248	+14.98	+0.93	15.76	-47.3	-31.5
364	4:01	599	177	806	-207								

GRAVITY DATA

Project Ogyuna Range Operator G. A. Durfee Date August 16, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	g	g	Elev.	Corrections Elev.	Corrections Lab.	Cor. g	Base	g
			174									
364	9:23	596	177	803	-207							
457	9:45	515	175	803	-288	-4.02	1256	+14.35	+2.23	13.57	-47.3	-33.7
458	9:52	422	175	803	-381	-7.27	1288	+17.22	+3.54	13.55	-47.3	-33.7
459	10:02	410	175	803	-393	-7.69	1264	+15.[illegible]	+5.20	13.43	-47.3	-33.9
460	10:09	366	175	803	-437	-9.21	1264	+15.[illegible]	+6.11	12.74	-47.3	-34.6
461	10:19	270	175	804	-534	-12.61	1268	+16.[illegible]	+7.27	10.74	-47.3	-36.6
462	10:27	128	175	804	-682	-17.77	1265	+15.90	+8.75	6.88	-47.3	-40.4
463	10:35	313	173	806	-491	-23.21	1264	+15.84	+9.40	2.03	-47.3	-45.3
464	10:49	231	173	805	-574	-26.11	1293	+17.55	+9.55	1.03	-47.3	-46.3
186	11:08	289	175	805	-516	-11.98	Tie -- +4.08 mg					
465	11:26	360	175	805	-425	-8.05	1274	+16.44	+5.12	13.51	-47.3	-33.8
364	12:34	598	177	805	-207							
466	12:52	616	174	805	-189	-6.61	1239	+14.34	+3.52	11.25	-47.3	-36.1
467	1:08	401	174	806	-405	-14.15	1279	+16.74	+4.80	7.39	-47.3	-39.9
452	1:17	386	174	806	-423	-14.61	1261	+15.66	+6.11	7.16	-47.3	-40.1
451	1:27	489	174	806	-317	-11.09	1258	+15.48	+7.44	11.83	-47.3	-35.5
468	1:35	352	174	806	-454	-15.86	1257	+15.42	+8.72	8.28	-47.3	-39.0
469	1:45	253	174	806	-553	-19.31	1240	+14.40	+10.02	5.11	-47.3	-42.2
470	1:54	225	174	806	-581	-20.30	1291	+17.42	+11.32	8.48	-47.3	-38.8
471	2:01	344	174	807	-463	-16.17	1271	+16.26	+12.32	12.41	-47.3	-34.9
472	2:15	372	172	807	-435	-27.30			+13.12			
473	2:21	334	172	807	-473	-28.63			+13.70			
474	2:33	468	172	807	-339	-23.95			+12.90			
475	3:29	639	170	808	-169	+18.30	1220	+13.80	+6.97	24.43	-47.3	-22.9
476	3:39	575	178	809	-234	+16.02	1218	+13.08	+6.30	22.60	-47.3	-24.7
364	4:06	602	177	809	-207							

GRAVITY DATA

Project Cayuna Range Operator G. A. Durfee Date August 17, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Corrections Cor.	g	Base	g
11	8:55	305	177	305	0								
274	9:23	254	177	305	-51		Tie —	0.00 mg					
477	9:37	286	177	305	-19	-0.66	1207	+12.42	-7.82	3.94	-47.3	-43.4
478	9:45	256	177	305	-49	-1.71	1232	+13.92	-8.10	4.11	-47.3	-43.2
479	9:57	335	177	304	+31	+1.08	1218	+13.08	-9.77	4.39	-47.3	-42.9
480	10:00	330	177	304	+26	+0.91	1209	+12.54	-9.77	3.68	-47.3	-43.6
481	10:06	363	177	304	+59	+2.06	1209	+12.54	-9.73	4.87	-47.3	-42.4
482	10:12	424	177	304	+120	+4.19	1201	+12.06	-9.55	6.60	-47.3	-40.7
483	10:20	407	177	304	+103	+3.60	1233	+13.98	-10.28	7.39	-47.3	-40.0
484	10:27	491	177	304	+187	+6.53	1213	+12.78	-10.33	8.98	-47.3	-38.3
485	10:37	513	177	304	+209	+7.30	1205	+12.30	-11.67	7.93	-47.3	-39.4
486	10:47	552	177	304	+248	+8.66	1227	+13.62	-12.97	9.31	-47.3	-38.0
487	10:57	635	177	304	+331	+11.56	1240	+14.40	-14.15	11.81	-47.3	-35.5
488	11:05	639	177	304	+335	+11.71	1240	+14.40	-14.15	11.96	-47.3	-35.3
489	11:11	617	177	304	+313	+10.94	1245	+14.70	-14.15	11.49	-47.3	-35.8
490	11:24	451	177	304	+147	+5.14	1239	+14.34	-14.79	4.69	-47.3	-42.6
491	11:43	423	177	304	+117	+4.09	1253	+15.18	-15.42	3.85	-47.3	-43.5
492	11:53	503	177	304	+199	+6.95	1248	+14.88	-16.58	5.15	-47.3	-42.1
11	12:58	303	177	303	0								
493	1:53	158	177	303	-145	-5.07	1215	+12.90	+5.00	12.83	-47.3	-34.5
494	2:18	369	175	303	+66	-9.79	1277	+16.62	+5.16	12.99	-47.3	-34.3
495	2:35	253	175	303	-50	-13.85	1311	+18.66	+5.47	10.88	-47.3	-37.0
496	3:04	379	175	303	+76	-9.44	1256	+15.36	+4.97	10.89	-47.3	-36.4
497	3:42	594	175	303	+291	-1.91	1196	+11.76	+2.73	12.78	-47.3	-34.5
498	3:55	484	175	303	+181	-5.78	1270	+16.20	+5.52	15.94	-47.3	-31.4
11	4:12	303	177	303	0								

GRAVITY DATA

Project Oquna Range Operator G. A. Durfee Date August 18, 1955

Station	Time	Reading Sm. Dial	Reading Lg. Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Corrections Cor.	g	Base	g
11	8:12	642	175	642	0								
11	1:25	637	175	637	0								
7	1:52	440	175	636	-196		Tie — -0.07 mg						
499	2:06	320	175	636	-316	-11.05	1262	+15.72	+9.03	13.70		-47.3	-33.6
500	2:14	304	175	636	-332	-11.60	1281	+16.36	+10.03	15.29		-47.3	-32.0
501	2:21	284	175	636	-352	-12.31	1274	+16.44	+11.76	14.89		-47.3	-32.4
502	2:30	240	175	635	-395	-13.80	1285	+17.10	+11.33	14.63		-47.3	-32.7
503	2:37	150	175	635	-485	-16.95	1312	+18.72	+12.62	14.39		-47.3	-32.9
504	2:50	147	175	635	-488	-17.05	1274	+16.44	+13.57	12.96		-47.3	-34.3
11	4:55	632	175	632	0								

GRAVITY DATA

Project Guyuna Range Operator G. A. Durfee Date August 22, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Cor. g	Base	g
11	2:23	705	175	705	0							
505	2:32	778	175	705	+73	+2.55	1233	+13.[illegible]8	+0.93	17.46	-47.3	-29.8
506	2:41	750	175	705	+45	+1.57	1228	+13.68	0.00	15.25	-47.3	-32.1
507	2:52	312	178	705	-393	+4.41	1204	+12.24	-1.35	15.89	-47.3	-32.0
508	3:04	396	178	706	-310	+7.32	1211	+12.66	-2.03	17.95	-47.3	-29.3
509	3:14	395	178	706	-311	+7.29	1218	+13.08	-2.38	17.99	-47.3	-29.3
510	3:25	384	178	706	-322	+6.89	1227	+13.62	-2.86	17.65	-47.3	-29.7
47	3:31	297	178	706	-409	+3.85	Tie → -0.06 mg					
511	3:40	226	178	706	-480	+1.73	1212	+12.72	-4.12	10.33	-47.3	-37.0
512	3:50	181	178	706	-525	-0.20	1212	+12.72	-4.25	8.27	-47.3	-39.0
513	4:00	125	178	707	-582	-2.17	1233	+13.[illegible]	-4.25	7.56	-47.3	-39.7
514	4:19	356	177	707	-351	-0.16	1254	+15.24	-2.99	12.09	-47.3	-35.2
515	4:27	295	178	707	-409	+3.85	1218	+13.08	-2.09	14.84	-47.3	-32.5
516	4:32	210	178	707	-497	+0.69	1239	+14.3[illegible]	-1.65	13.38	-47.3	-33.9
517	4:47	234	178	707	-473	+1.60	1212	+12.[illegible]	-0.94	13.38	-47.3	-33.9
518	4:53	270	178	708	-438	+2.85	1198	+11.68	-0.81	13.92	-47.3	-33.4
519	5:00	135	178	708	-573	-1.85	1244	+14.[illegible]	+0.64	13.43	-47.3	-33.9
520	5:12	172	178	708	-536	-0.58	1259	+15.[illegible]	+1.90	16.86	-47.3	-30.4
11	5:20	708	175	708	0							

GRAVITY DATA

Project Cayuna Range Operator G. A. Durfee Date August 23, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Reading Base	R	g	Corrections Elev.	Corrections Elev.	Corrections Lat.	Corrections Cor. g	Base	g
11	8:26	564	176	564	0							
521	8:44	664	176	564	+100	+3.49	1233	+13.98	-1.74	15.73	-47.3	-31.6
522	8:54	595	176	564	+31	+1.08	1253	+15.18	-1.74	14.52	-47.3	-32.8
523	9:05	602	176	564	+38	+1.33	1241	+14.46	-1.74	14.05	-47.3	-33.3
524	9:12	592	176	564	+28	+0.98	1253	+15.18	-2.39	13.78	-47.3	-33.5
525	9:39	583	176	564	+19	+0.66	1250	+15.00	+0.14	15.80	-47.3	-31.5
526	9:49	539	176	564	-25	-0.88	1265	+15.90	+1.08	16.10	-47.3	-31.2
11	10:24	564	176	564	0							
527	10:57	514	176	565	-51	-1.78	1200	+12.00	+17.95	28.17	-47.3	-19.1
528	11:05	317	176	565	-248	-8.68	1292	+17.52	+19.23	28.07	-47.3	-19.2
529	11:15	248	176	565	-318	-11.13	1296	+17.76	+21.62	28.25	-47.3	-19.1
530	11:23	229	176	566	-337	-11.80	1311	+18.66	+20.53	27.39	-47.3	-19.9
531	11:33	270	176	566	-296	-10.35	1299	+17.94	+20.53	28.12	-47.3	-19.2
532	11:49	464	176	567	-103	-3.60	1275	+16.50	+15.32	28.22	-47.3	-19.1
533	11:55	511	176	567	-56	-1.96	1268	+16.08	+14.31	28.43	-47.3	-18.9
60	12:07	450	176	567	-117	-4.09	Tie --	0.00 mg				
11	12:39	568	176	568	0							

GRAVITY DATA

Project Guyana Range Operator G. A. Durfee Date August 24, 1955

Station	Time	Reading Sm. Dial	Reading Lg. Dial	Base	R	g	Elev.	Corrections Elev.	Corrections Lat.	Corrections Cor.	g	Base	g
11	11:21	570	176	570	0								
128	11:43	711	176	570	+141								
129	11:49	747	176	570	+177								
259	11:55	763	176	570	+193								
11	1:22	569	176	569	0								
228	1:40	619	176	569	+50								
232	2:09	588	176	568	+20								
11	2:35	568	176	568	0								

Date August 25, 1955

Station	Time	Sm. Dial	Lg. Dial	Base	R	g	Elev.	Elev.	Lat.	Cor.	g	Base	g
11	8:10	590	172	590	0								
229	8:33	620	172	591	+29								
230	8:43	623	172	591	+32								
231	8:50	625	172	592	+33								
228	9:10	644	172	592	+52								
11	9:27	593	172	593	0								

GRAVITY DATA

Project Guyana Range Operator G. F. Durfee Date August 29, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	E	g	Elev.	Corrections Elev.	Corrections Lat.	Corrections Cor.	g	Base	g
			177										
364	10:35	253	180	460	-207								
534	10:50	268	180	460	-192	+11.43	1209	+13.94	-2.73	21.14		-47.3	-26.2
417	11:15	312	178	461	-149	+0.85	Tie --	0.00					
535	11:23	310	178	461	-151	+0.77	1268	+16.06	-3.70	13.25		-47.3	-34.1
536	11:34	356	178	461	-105	+2.38	1294	+15.24	-4.48	13.14		-47.3	-34.2
537	11:45	289	178	461	-172	+0.94	1270	+15.20	-4.48	11.76		-47.3	-35.5
538	11:55	501	178	462	+32	+7.41	1245	+14.70	-5.76	16.35		-47.3	-30.9
539	12:06	363	180	462	-99	+14.69	1219	+13.14	-7.06	20.77		-47.3	-26.5
540	12:16	501	180	462	+119	+22.31	1230	+13.00	-8.50	27.01		-47.3	-20.7
541	12:31	384	178	462	-78	+3.32	1232	+13.02	-3.15	14.09		-47.3	-33.2
542	12:42	426	178	463	-37	+4.76	1255	+15.30	-1.84	18.22		-47.3	-29.1
543	12:52	397	178	463	-66	+3.74	1226	+13.56	-0.51	16.79		-47.3	-30.5
544	1:02	346	178	463	-117	+1.96	1278	+16.68	+2.12	20.76		-47.3	-26.5
545	1:10	383	178	463	-80	+3.25	1236	+14.16	+0.82	18.23		-47.3	-29.1
364	1:52	257	180	464	-207								

GRAVITY DATA

Project Oquinna Range | Operator O. A. Durfee | Date September 1, 1955

Station	Time	Reading Sm.Dial	Reading Lg.Dial	Base	H	δ	Elev.	Corrections Elev.	Corrections Lat.	Cor.	g	Base	g
11	2:15	534	177	534	0								
546	2:35	485	177	535	-20	-1.75	1226	+13.56	-0.87	10.94		-47.3	-36.4
547	2:50	559	177	535	+24	+0.84	1233	+13.98	-1.72	13.10		-47.3	-34.2
548	2:59	512	177	535	-24	-0.84	1238	+14.28	-2.39	11.05		-47.3	-36.3
515	3:08	643	177	536	+107	+3.74	Tie — -0.11 mg						
549	3:23	538	177	537	+1	+0.03	1264	+15.84	+1.44	17.31		-47.3	-30.0
11	3:30	537	177	537	0								