IOWA GEOLOGICAL SURVEY
IOWA CITY, IOWA
H. GARLAND HERSHEY, Director and State Geologist

REPORT OF INVESTIGATIONS 8

IOWA GRAVITY BASE STATION NETWORK

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IOWA GRAVITY BASE STATION NETWORK

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D. H. HASE, RUSSELL B. CAMPBELL, and ORVILLE J VAN ECK

ABSTRACT

In the spring of 1967, the Iowa Geological Survey established 42 gravity base stations at airports throughout the state to provide a more adequate and extensive gravity base station network than had existed previously. Measurements were made with LaCoste-Romberg geodetic gravity meters and were tied to the U. S. National Gravity Base Net through station Minneapolis L (I. G. C. 15443L). For all but one station, the maximum network uncertainty at any station is ±0.041 milligal. One U. S. Air Force and two Woollard and Rose (1963) stations were recovererd, and the differences in observed gravity measured by the Iowa Geological Survey and reported at these stations are −0.005, 0.00, and −0.02 milligal respectively.

INTRODUCTION

The number of gravity measurements throughout the state has increased in recent years owing to interest in the mid-continent gravity high and to efforts by industry to locate petroleum-bearing structures and structures to store natural gas. There is also interest in obtaining additional geophysical data in areas of magnetic anomalies previously defined by an airborne magnetometer survey of the state which was begun in 1961 and is now about three-fourths completed. Prior to this gravity base station network survey, 5 pendulum base stations (Duerksen, 1949) and 12 gravity meter base stations (Woollard and Rose, 1963) had been established in the state. Some of these stations are inconveniently located; others are lost or inaccessible because of construction.

The objective of the survey was to establish with the most accurate gravity meters available a more adequate and extensive gravity control network at more uniformly distributed base stations which would facilitate the integration of local gravity surveys into the network for application to regional geophysical and geological investigations. The Iowa Geological Survey gravity base station network was planned so as to recover some of the Woollard and Rose airport gravity meter bases. The base stations in the Iowa

(IGS) network are tied to the U. S. National Gravity Base Net using Washington A, 980.188000 gals, as the base station and through it to the international gravity net, thus making gravity data in the state available for worldwide geologic and geodetic studies.

The LaCoste-Romberg geodetic gravity meters used in the survey were made available through the courtesy of R. M. Iverson, Army Map Service, Washington, D. C. The GRAVAS gravity reduction program was adapted by D. J. Gockel, U. S. Geological Survey, Iowa City, Iowa to run on the IBM 360/65 computer at The University of Iowa. We are indebted to the officers and men of the Iowa Army National Guard who provided air transportation and to our colleagues who assisted in obtaining field observations.

INSTRUMENTATION AND METHOD OF SURVEY

Most of the gravity measurements were made with LaCoste-Romberg geodetic gravity meters Nos. G-142 and G-143, and additional ties between the stations at Minneapolis, Minnesota and Waterloo, Iowa were made with geodetic gravity meter No. G-59. The meters are well suited for this type of work because of a very low drift rate, a reading sensitivity of about 5 microgals, and a large reading range. The calibration factors supplied by the manufacturer for each instrument were used in the computations.

The gravity base station network values have been determined on the basis of differences in gravity relative to the U. S. Air Force gravity station at the International Airport Terminal (Wold-Chamberlain Field), Minneapolis, Minnesota (Minneapolis L; I. G. C. 15443L) at which the adjusted value is 980.594651 gals.

Observations for the gravity base station network were made in a series of loops which closed on the same base from which the loop originated. Five auxiliary base stations were established in the state to facilitate this procedure. During the period 11 April through 16 May 1967, stations were established at 42 airports throughout the state by 17 loops. Air transportation was used for nine loops, and ground transportation was used for the remainder. The time required to complete a loop ranged from a minimum of 2½ hours to a maximum of 10½ hours.

Most of the stations were established inside airport terminal buildings or hangers which are expected to have a permanency of at least 10 years. Airport elevations listed on the Dubuque and Des Moines

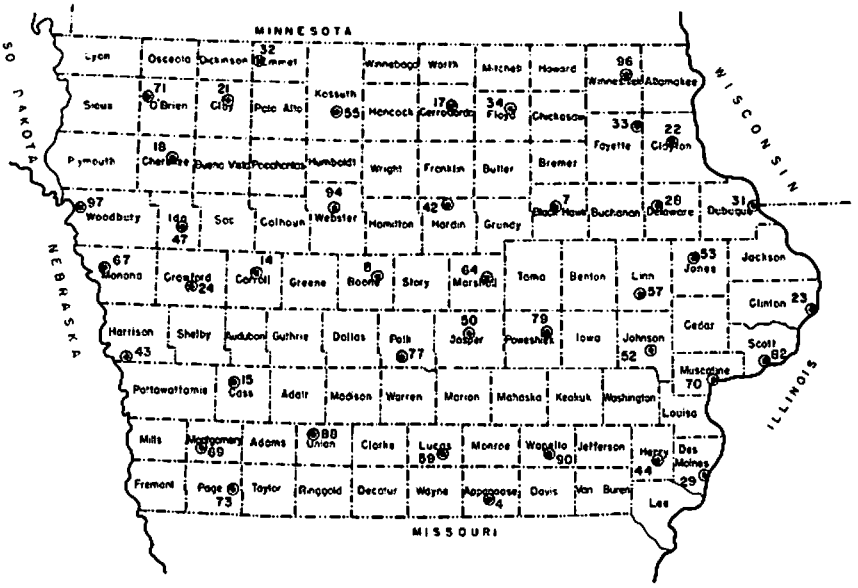

Figure 1. Location of gravity base stations, Iowa Geological Survey network.

sectional aeronautical charts (Department of Commerce, 1966) were used for station elevations with the exception that elevations of stations obviously above or below the elevation of the field were surveyed by levelling from the field. The elevations of all station sites are believed to be accurate to within one meter of the listed elevation of the field.

The raw field data were processed by GRAVAS, a computer program written in Fortran language to reduce LaCoste-Romberg gravity meter observations to corrected observed gravity and free air and simple Bouguer anomaly values (Army Map Service, 1967). Some minor reprogramming was required to adapt GRAVAS to run on an IBM 360/65 computer.

RESULTS

The location and distribution of the 42 base stations in the IGS network are shown on figure 1. The base station number corresponds to the alphabetical county number, for in the event that the network is expanded in the state, it is envisioned that only one base

Table 1. — Gravity data at base stations

Station number and location	Mean value observed gravity (gals.) and number of occupations	Maximum deviation single meter ± (milligals)	Maximum deviation between meters ± (milligals)
IGS 4 Centerville	980.134317 (4)	0.002	0.051
IGS 7 Waterloo	980.302465 (20)	0.029	0.034
IGS 8 Boone	980.321269 (16)	0.025	0.047
IGS 14 Carroll	980.251273 (4)	0.025	0.018
IGS 15 Atlantic	980.261649 (4)	0.008	0.004
IGS 17 Mason City	980.421396 (2)	0.012	(*)
IGS 18 Cherokee	980.312210 (4)	0.031	0.010
IGS 21 Spencer	980.309352 (4)	0.024	0.037
IGS 22 Elkader	980.358497 (4)	0.041	0.031
IGS 23 Clinton	980.268003 (4)	0.034	0.012
IGS 24 Denison	980.192478 (2)	0.010	(*)
IGS 28 Manchester	980.359958 (4)	0.010	0.015
IGS 29 Burlington	980.164849 (4)	0.018	0.009
IGS 31 Dubuque	980.300247 (4)	0.073	0.008
IGS 32 Estherville	980.349518 (4)	0.009	0.068
IGS 33 Clermont	980.377610 (4)	0.044	0.002
IGS 34 Charles City	980.317721 (2)	0.001	(*)
IGS 42 Iowa Falls	980.276162 (2)	0.029	(*)
IGS 43 Missouri Valley	980.168165 (2)	0.007	(*)
IGS 44 Mount Pleasant	980.179060 (4)	0.013	0.009
IGS 47 Ida Grove	980.264068 (4)	0.003	0.027
IGS 50 Newton	980.220279 (4)	0.007	0.020
IGS 52 Iowa City	980.251791 (16)	0.010	0.022
IGS 53 Monticello	980.282053 (4)	0.029	0.011
IGS 55 Algona	980.340242 (4)	0.011	0.042
IGS 57 Cedar Rapids	980.251028 (4)	0.022	0.031
IGS 59 Chariton	980.163338 (4)	0.006	0.014
IGS 64 Marshalltown	980.250637 (8)	0.008	0.047
IGS 67 Onawa	980.262991 (2)	0.016	(*)
IGS 69 Red Oak	980.150110 (4)	0.012	0.031
IGS 70 Muscatine	980.231669 (4)	0.030	0.004
IGS 71 Sheldon	980.340850 (4)	0.011	0.056
IGS 73 Clarinda	980.111550 (4)	0.024	0.015
IGS 77 Des Moines	980.198087 (16)	0.020	0.019
IGS 79 Brooklyn	980.243659 (4)	0.023	0.052
IGS 82 Davenport	980.250280 (12)	0.024	0.062
IGS 88 Creston	980.132224 (4)	0.044	0.017
IGS 90 Ottumwa	980.183328 (4)	0.012	0.023
IGS 92 Washington	980.205721 (4)	0.012	0.013
IGS 94 Fort Dodge	980.295319 (4)	0.040	0.043
IGS 96 Decorah	980.415955 (4)	0.015	0.029
IGS 97 Sioux City	980.306701 (4)	0.013	0.026

*Single meter; readings from G-142 rejected on two loops because of malfunction

station will be established in each county, and each base station can thus be indexed according to the county number.

Ten interval values were obtained between the U. S. Air Force gravity station, Minneapolis L, and the primary base station of the IGS network at Waterloo, IGS 7. The observed gravity at Waterloo is 980.302465 gals, and the maximum uncertainty on the loops is ±0.048 milligal.

The mean value at each base station, the number of occupations, the maximum deviation upon reoccupation for a single meter, and the maximum deviation between the two meters are listed in table 1. The maximum deviation is ±0.073 milligal, resulting from a single occupation at IGS 31 Dubuque, which suggests that the internal uncertainty of the entire network is on the order of ±0.10 milligal. However, the internal uncertainty of most of the network may more reasonably be on the order of ±0.05 milligal, based on evaluation of the data after three observations were rejected because they were outside the designated accuracy limit of 0.05 milligals for the survey. This evaluation indicates that the maximum network uncertainty at any station is ±0.041 milligal, the mean is ±0.036 milligal, and the root mean square is ±0.027 milligal. The values for maximum deviation of observed gravity between the two meters at any given station further corroborates the internal accuracy of the network.

Table 2 (Appendix) gives the station descriptions and observed gravity for all stations in the IGS network as well as the elevation, latitude, longitude, free air gravity and simple Bouguer gravity calculated for a density of 2.67.

COMPARISON WITH OTHER GRAVITY BASES

The gravity values and differences between observations made at or near six previously established stations reported by Woollard and Rose (1963) are compared in table 3. A more valid comparison is obtained after the IGS values are adjusted by a factor of +0.8 milligal inasmuch as the IGS stations are tied to Washington A base, value 980.118000 gals. and the Woollard and Rose stations are also tied to Washington A base, assigned value 980.118800 gals. The adjusted differences between the two sets of data range from 0.45 to −0.53 milligal. Although the IGS and the Woollard and Rose stations at both Cedar Rapids and Des Moines are not on precisely the same sites, the Woollard and Rose stations were recovered and separate ties were made between them and the new IGS stations.

Table 3. — Comparison of Iowa Geological Survey (IGS) and Woollard (WA) gravity values

Station Number and Location	A IGS (gals)	B WA (gals)	Difference (A − B) (mgals)	Adjusted Difference (mgals) [(A+0.8) − B] (mgals)
Minneapolis L (WA 118)	980.594651	980.5950	−0.35	0.45
IGS 8 Boone (WA 220)	980.321269	980.3226	−1.33	−0.53
IGS 31 Dubuque (WA 224)	980.300247	980.3014	−1.15	−0.35
IGS 57 Cedar Rapids (WA 24)*	980.251085	980.2519	−0.82	−0.02
IGS 77 Des Moines (WA 25)*	980.197597	980.1984	−0.80	0.00
IGS 82 Davenport (WA 226)	980.250280	980.2509	−0.62	0.18
IGS 97 Sioux City (WA 228)	980.306701	980.3073	−0.60	0.20

*IGS station values adjusted to WA station values by separate ties.

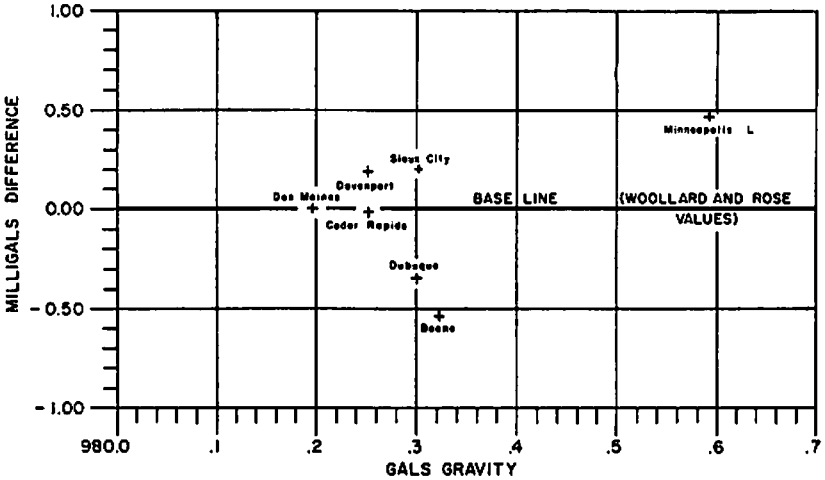

Figure 2. Comparison of Iowa Geological Survey gravity values with Woollard and Rose (1963) gravity values (base line).

The differences between the two sets of data are −0.02 milligal at Cedar Rapids and 0.00 milligal at Des Moines. This would therefore indicate very close agreement between the two surveys.

The Woollard and Rose stations at Davenport and Sioux City were "partially" recovered inasmuch as the respective IGS stations are believed to be within 200 feet of them. Reconstruction of the terminal facilities at these airports has made the exact location of the previously established stations doubtful. The difference between the IGS and the Woollard and Rose values at Davenport is 0.18 milligal and at Sioux City is 0.20 milligal. A difference in observed gravity of −0.005 milligal was obtained at IGS 97 Sioux City, value 980.306701 gals, which is on the site of the U. S. Air Force station Sioux City J (I.G.C. 15426J), value 980.306706 gals.

Attempts to recover the Woollard and Rose stations near Minneapolis L, IGS 8 Boone, and IGS 31 Dubuque were unsuccessful, and differences in location between the respective stations are very probably on the order of hundreds of feet. The comparisons are not significant and are included only for completeness.

The comparison between the IGS gravity values and the Woollard and Rose gravity values using the latter as the base line is illustrated in figure 2. Discounting the values obtained at Minneapolis, Boone, and Dubuque where the Woollard and Rose stations were not recovered, the differences between the two sets of data from the

"partially" recovered stations at Davenport and Sioux City are 0.20 milligal or less and from the recovered stations at Cedar Rapids and Des Moines are 0.02 milligal or less. No systematic variation with gravity is apparent in the data.

CONCLUSIONS

The Iowa Geological Survey study has provided a more adequate and extensive gravity base station network tied to the U. S. National Gravity Base Net which will augment the inadequate net that previously existed in the state. The maximum uncertainty at one station is ±0.073 milligal, but at all other stations the uncertainty is about ±0.05 milligal with reference to the base value used.

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APPENDIX

Table 2. — Gravity data and station descriptions

NO.	STATION	COUNTY	NORTH LATITUDE	WEST LONGITUDE	ELE-VATION (FEET)	OBSERVED GRAVITY	FREE AIR ANOMALY	SIMPLE BOUGUER ANOMALY
IGS 4	Centerville	Appanoose	40° 41.0′	92° 54.0′	1023	980 134.317	—10.785	—45.686
	At the Centerville Municipal Airport, 3.5 miles southwest of the town of Centerville; in the northeast corner of the east hangar; marked with an orange paint spot.							
IGS 7	Waterloo	Black Hawk	42° 33.0′	92° 23.3′	871	980 302.465	—24.391	—54.077
	At the Waterloo Municipal Airport, 6 miles northwest of the city of Waterloo; in the cargo room of the terminal building, at the base of the I-beam on the north wall, between the door leading to the ramp and the door leading to the basement; marked with an orange paint spot.							
IGS 8	Boone	Boone	42° 03.2′	93° 51.2′	1147	980 321.269	65.232	26.095
	At the Boone Municipal Airport, 1/2 mile southeast of the town of Boone; in the northeast corner of the hangar, between the door from the airport manager's office and the hot water heater; marked with an orange paint spot.							
IGS 14	Carroll	Carroll	42° 03.0′	94° 47.0′	1202	980 251.273	0.707	—40.307
	At the Carroll Municipal Airport, 4 miles east-southeast of the town of Carroll; along the north wall of the main floor of the terminal building, east of the windows and about 1 meter west of the door leading to the ramp; not marked.							

NO.	STATION	COUNTY	NORTH LATITUDE	WEST LONGITUDE	ELEVATION (FEET)	OBSERVED GRAVITY	FREE AIR ANOMALY	SIMPLE BOUGUER ANOMALY
IGS 15	Atlantic	Cass	41° 24.0′	95° 03.0′	1158	980 261.649	65.210	25.697
	At the Atlantic Municipal Airport, 1 mile west of the town of Atlantic; in the southeast corner of the airport manager's office, between the doors to the rest rooms; marked with an orange paint spot.							
IGS 17	Mason City	Cerro Gordo	43° 09.0′	93° 20.0′	1216	980 421.396	73.237	31.745
	At the Mason City Municipal Airport, 8 miles west of the city of Mason City; in the drive-through between the terminal building and the hangar, below the thermostat on the east wall; marked with an orange paint spot.							
IGS 18	Cherokee	Cherokee	42° 44.0′	95° 33.0′	1212	980 312.210	1.417	40.175
	At the Cherokee Municipal Airport, 1 mile south of the town of Cherokee; in the north end of the terminal building, in the middle of the floor, on the inlaid compass rose.							
IGS 21	Spencer	Clay	43° 10.0′	95° 12.0′	1335	980 309.352	29.115	74.667
	At the Spencer Municipal Airport, 3 miles northwest of the city of Spencer; in the terminal building, in the southeast corner of the office area between the windows and the back of the service counter; marked with an orange paint spot.							
IGS 22	Elkader	Clayton	42° 50.8′	91° 22.5′	932	980 358.497	10.937	20.864
	At the Elkader Municipal Airport, 1.5 miles southeast of the town of Elkader; on the concrete sidewalk on the west side of the office midway between the door and the window; marked with an orange paint spot.							

NO.	STATION	COUNTY	NORTH LATITUDE	WEST LONGITUDE	ELEVATION (FEET)	OBSERVED GRAVITY	FREE AIR ANOMALY	SIMPLE BOUGUER ANOMALY
IGS 23	Clinton	Clinton	41° 49.5′	90° 19.8′	708	980 268.003	—8.830	—32.988
	At the Clinton Municipal Airport, 7 miles west-southwest of the city of Clinton; in the northeast corner of the garage at the west end of the terminal building; marked with an orange paint spot.							
IGS 24	Denison	Crawford	41° 59.0′	95° 23.0′	1275	980 192.478	—45.240	—88.744
	At the Denison Municipal Airport, 3 miles southwest of the town of Denison; on the apron at the southwest end of the sidewalk leading from the terminal building; marked with an orange paint spot.							
IGS 28	Manchester	Delaware	42° 30.0′	91° 30.0′	1000	980 359.958	49.975	15.852
	At the Manchester Municipal Airport, 3 miles west of the city of Manchester; outside and along the north side of the hangar, immediately west of the outside telephone booth; not marked.							
IGS 29	Burlington	Des Moines	40° 46.9′	91° 07.2′	697	980 164.849	—19.679	—43.471
	At the Burlington Municipal Airport, 1.7 miles south-southwest of the city of Burlington; about 1/2 meter from the south wall of the exit way, near the door leading to the ramp on the west side of the terminal building, below the weather information board; marked with an orange paint spot.							
IGS 31	Dubuque	Dubuque	42° 24.3′	90° 42.2′	1076	980 300.247	5.948	—30.766
	At the Dubuque Municipal Airport, 7.5 miles south-southwest of the city of Dubuque; in the west corner of the concrete block maintenance garage; marked with a red paint spot.							

NO.	STATION	COUNTY	NORTH LATITUDE	WEST LONGITUDE	ELEVATION (FEET)	OBSERVED GRAVITY	FREE AIR ANOMALY	SIMPLE BOUGUER ANOMALY
IGS 32	Estherville	Emmet	43° 25.0′	94° 45.0′	1317	980 349.518	—13.166	—58.103
	At the Estherville Municipal Airport, 4 miles east of the town of Estherville; in the northeast corner of the terminal building, below the bulletin board; not marked.							
IGS 33	Clermont	Fayette	42° 59.0′	91° 39.0′	869	980 377.610	11.823	—17.827
	At the Clermont Municipal Airport (Valley), 1/2 mile south of the town of Clermont; by the doors on the north side of the hangar, on the concrete dividing strip; marked with a red paint spot.							
IGS 34	Charles City	Floyd	43° 04.0′	92° 36.0′	1130	980 317.721	—31.022	—69.579
	At the Charles City Municipal Airport, 3 miles east of the town of Charles City; in the northeast corner of the middle hangar, inside the north door; marked with an orange paint spot.							
IGS 42	Iowa Falls	Hardin	42° 28.0′	93° 16.0′	1140	980 276.162	—17.660	—56.558
	At the Iowa Falls Municipal Airport, 3 miles south of the town of Iowa Falls; in the southeast corner of the hangar, about 1/2 meter northwest of the block wall between the hangar door and the door to the office; marked with a red paint spot.							
IGS 43	Missouri Valley	Harrison	41° 32.0′	95° 53.0′	1000	980 168.165	—55.072	—89.194
	At the Missouri Valley Municipal Airport, 1 mile south of the town of Missouri Valley; outside and at the northwest corner of the middle hangar, adjacent to a U. S. G. S. monument set in a cement post approximately even with the ground.							

NO.	STATION	COUNTY	NORTH LATITUDE	WEST LONGITUDE	ELEVATION (FEET)	OBSERVED GRAVITY	FREE AIR ANOMALY	SIMPLE BOUGUER ANOMALY
IGS 44	Mount Pleasant	Henry	40° 57.0′	91° 31.0′	727	980 179.060	—17.676	—42.481
	At the Mount Pleasant Municipal Airport, 3 miles southeast of the city of Mount Pleasant; in the northwest corner of the waiting room in the terminal building, about 1/2 meter from the west wall, between the windows and the door leading to the basement; marked with an orange paint spot.							
IGS 47	Ida Grove	Ida	42° 20.0′	95° 27.0′	1250	980 264.068	—7.426	—50.078
	At the Ida Grove Municipal Airport, 1/2 mile east-southeast of the town of Ida Grove; along the outside of the southwest side of the terminal building, in line with the sidewalk leading from the field; marked with an orange paint spot.							
IGS 50	Newton	Jasper	41° 40.7′	93° 01.5′	953	980 220.279	—20.369	—52.886
	At the Newton Municipal Airport, 1.5 miles southeast of the city of Newton; in the northeast hangar, along the northwest wall, between the door leading to the waiting room and the first support pillar to the southwest; marked with an orange paint spot.							
IGS 52	Iowa City	Johnson	41° 38.4′	91° 32.5′	661	980 251.791	—12.734	—35.288
	At the Iowa City Municipal Airport, 2 miles south of the city of Iowa City; near the east entrance outside the terminal building, along the offset north wall between the entrance and the outside telephone booth; marked with a red paint spot.							
IGS 53	Monticello	Jones	42° 14.0′	91° 10.0′	847	980 282.053	—18.360	—47.261
	At the Monticello Municipal Airport, 1 mile southeast of the town of Monticello; in the northwest corner of the storage room east of the office, near the water heater tank; marked with an orange paint spot.							

NO.	STATION	COUNTY	NORTH LATITUDE	WEST LONGITUDE	ELEVATION (FEET)	OBSERVED GRAVITY	FREE AIR ANOMALY	SIMPLE BOUGUER ANOMALY
IGS 55	Algona	Kossuth	43° 04.0′	94° 16.0′	1219	980 340.242	— 0.140	—41.725
	At the Algona Municipal Airport, 2 miles west of the town of Algona; in the southeast corner of the airport manager's office; not marked.							
IGS 57	Cedar Rapids	Linn	41° 53.0′	91° 42.0′	863	980 251.028	—16.464	—45.911
	At the Cedar Rapids Municipal Airport, 6.5 miles southwest of the city of Cedar Rapids; along the south wall of the east waiting room of the terminal building, below the windows and about 1 meter west of the trophy case; marked with an orange paint spot.							
IGS 59	Chariton	Lucas	41° 01.0′	93° 21.0′	1050	980 163.338	—8.976	—44.804
	At the Chariton Municipal Airport, 2.5 miles west of the town of Chariton; on the edge of the apron at the southwest corner of the north hangar; marked with an orange paint spot.							
IGS 64	Marshalltown	Marshall	42° 06.4′	92° 55.5′	972	980 250.637	—26.496	—59.662
	At the Marshalltown Municipal Airport, 4 miles north of the city of Marshalltown; inside the hangar just to the southeast of the manager's office building, along the northeast wall between the hangar door and the personnel door, marked with an orange paint spot.							
IGS 67	Onawa	Monona	42° 02.0′	96° 06.0′	1056	980 262.991	0.190	—35.842
	At the Onawa Municipal Airport, 1 mile south of the town of Onawa; on the southwest side of the country club house, on the concrete slab in front of the outside telephone booth, near the main entrance to the club house; marked with an orange paint spot.							

NO.	STATION	COUNTY	NORTH LATITUDE	WEST LONGITUDE	ELEVATION (FEET)	OBSERVED GRAVITY	FREE AIR ANOMALY	SIMPLE BOUGUER ANOMALY
IGS 69	Red Oak	Montgomery	41° 00.0′	95° 15.0′	1044	980 150.110	—21.279	—56.902
	At the Red Oak Municipal Airport, 1.5 miles west of the city of Red Oak; along the west wall of the office, at the south end of the large wall map of the United States; about 1 meter north of the entrance door; not marked.							
IGS 70	Muscatine	Muscatine	41° 22.0′	91° 09.0′	546	980 231.669	—19.343	—37.974
	At the Muscatine Municipal Airport, 6 miles southwest of the city of Muscatine; in the first hangar north of the terminal building, along the north wall, at the base of the second I-beam east of the hangar doors which open to the west; not marked.							
IGS 71	Sheldon	O'Brien	43° 12.8′	95° 50.4′	1419	980 340.850	6.078	—42.340
	At the Sheldon Municipal Airport, 1 mile northeast of the town of Sheldon; on the southeast side of the terminal building, on the concrete sidewalk, northeast of the door leading to the ramp; marked with an orange paint spot.							
IGS 73	Clarinda	Page	40° 43.0′	95° 01.0′	992	980 111.550	—39.435	—73.284
	At the Clarinda Municipal Airport, 1 mile southeast of the town of Clarinda; on the concrete sidewalk just outside the south door of the airport office; marked with an orange paint spot.							
IGS 77	Des Moines	Polk	41° 31.5′	93° 38.9′	947	980 198.087	—29.984	—62.298
	At the Des Moines Municipal Airport, 4.5 miles southwest of the city of Des Moines; in the basement of the terminal building, in room 28, at the base of the column immediately to the right upon entering the room; not marked.							

NO.	STATION	COUNTY	NORTH LATITUDE	WEST LONGITUDE	ELEVATION (FEET)	OBSERVED GRAVITY	FREE AIR ANOMALY	SIMPLE BOUGUER ANOMALY
IGS 79	Brooklyn	Poweshiek	41° 45.0′	92° 25.0′	840	980 243.659	—14.035	—42.702
	At the Brooklyn Val-Air Airport, 2 miles east-northeast of the town of Brooklyn; at the south end of the concrete sidewalk outside of the airport manager's office, at the southwest corner of the hangar; marked with an orange paint spot.							
IGS 82	Davenport	Scott	41° 36.6′	90° 35.1′	753	980 250.280	—3.055	—28.748
	At the Davenport Municipal Airport; near the village of Mt. Joy; 6 miles north of the city of Davenport; in the terminal building, in the northeast corner of the waiting room, near the FFA Radio-weather telephone booth, about 1/2 meter from the east wall with the glass block window; marked with an orange paint spot.							
IGS 88	Creston	Union	41° 01.0′	94° 21.0′	1293	980 132.224	—17.237	—61.356
	At the Creston Municipal Airport; 3 miles south of the town of Creston; in the terminal building along the north wall of the waiting room, below the window and about 1 meter west of the counter; not marked.							
IGS 90	Ottumwa	Wapello	41° 06.2′	92° 26.1′	845	980 183.328	—16.011	—44.843
	At the Ottumwa Municipal Airport, 6 miles north-northwest of the city of Ottumwa; near the northwest corner of the terminal building, in front of the radiator along the north wall, between the public telephone booth on the west and the Hertz counter on the east; not marked.							
IGS 92	Washington	Washington	41° 16.0′	91° 41.0′	769	980 205.721	—15.370	—41.610
	At the Washington Municipal Airport, 1.5 miles south-southeast of the town of Washington; on the east side of the office building, on the concrete slab immediately south of the door; marked with a red paint spot.							

NO.	STATION	COUNTY	NORTH LATITUDE	WEST LONGITUDE	ELE-VATION	OBSERVED GRAVITY	FREE AIR ANOMAJ Y	SIMPLE BOUGUER ANOMALY
IGS 94	Fort Dodge	Webster	42° 33.0′	94° 11.0′	1165	980 295.319	—3.643	—43.394
	At the Fort Dodge Municipal Airport, 3.5 miles north of the city of Fort Dodge; outside the terminal building, along the south wall, on the concrete sidewalk just west of the door, below the outdoor telephone booth; marked with 2 orange paint spots.							
IGS 96	Decorah	Winneshiek	43° 17.0′	91° 45.0′	1154	980 415.955	49.956	10.580
	At the Decorah Municipal Airport, 3 miles southeast of the town of Decorah; in the south corner of the hangar, near the northeast wall of the office; marked with an orange paint spot.							
IGS 97	Sioux City	Woodbury	42° 24.0′	96° 23.0′	1096	980 306.701	14.781	—22.674
	At the Sioux City Municipal Airport, 4 miles south of the city of Sioux City; in the airport terminal building, in the northwest corner of the waiting room, north of the field entrance and south of the restaurant, in the corner formed by the flowerbox and the radiator; not marked.							