DEPARTMENT OF ENVIRONMENTAL PROTECTION AND ENERGY
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GRAVITY INVESTIGATIONS TO DELINEATE SUBSURFACE GEOLOGY
IN THE BEEMERVILLE INTRUSIVE COMPLEX AREA,
SUSSEX COUNTY, NEW JERSEY
GEOLOGIC MAP SERIES 92-2

## ABSTRACT

Bouguer gravity anomalies, residual gravity anomalies, and modeling of gravity profiles have been used to delineate the subsurface configuration of the main body of the Beemerville intrusive complex and the enclosing Paleozoic sedimentary rocks. Surface geologic data were used to constrain the models and aeromagnetic maps were used to assist in interpretation of anomalies.

A gravity high associated with the intrusive extends southwest from Beemerville. North-northwest—south-southeast trending gravity lows are associated with faulting within Proterozoic and Paleozoic rocks east of the study area.

The Beemerville intrusive complex appears to be thin near the surface, and to broaden and elongate with depth. It extends to the southwest and probably plunges at a high angle to the southeast. Paleozoic sediments deepen and thicken to the north-northeast.

## INTRODUCTION

The Beemerville intrusive complex in Sussex County, New Jersey consists of carbonatite-alkalic igneous rocks of Late Ordovician age. These are restricted in regional occurrence but vary widely in petrologic and intrusive character. Many previous studies have addressed the age, petrology, and petrography of the complex, but little has been done on its spatial properties, particularly with its vertical dimension. The purpose of this study is to delineate the subsurface configuration of the main body of the intrusive complex using gravity data in conjunction with aeromagnetic data and surface geologic information.

An area of about 384 square miles (614 sq km) was surveyed using the gravity method. Gravity observations were collected at 156 stations. These data were supplemented by gravity observations from 176 locations provided by Walter J. Spink (written communication, 1986).

## GENERAL GEOLOGY

The Beemerville intrusive complex lies within the Kittatinny Valley section of the Valley and Ridge Physiographic Province. Paleozoic sedimentary rocks overlie Middle Proterozoic metamorphic and igneous rocks (fig. 1, table 1). Surficial sediments are absent or only a few feet thick across most of the study area, thicker within an area extending south from Culvers Lake past Lake Owassa. In large part these date to the late Wisconsinan glaciation.

To the east, the New Jersey Highlands are underlain primarily by Proterozoic metamorphic and igneous rocks including gneiss, hornblende granite, alaskite, marbles and skarns, and amphibolite. Smaller areas are underlain by downfaulted Paleozoic sedimentary rocks unconformably overlying Proterozoic rocks. In both Kittatinny Valley and the Highlands, northeast-trending, moderate-to-high-angle faults cut both the Paleozoic and Proterozoic rocks. Detailed studies of the bedrock geology include Merchant and Teet (1954), Hague and others (1956), Spink (1967), Baker and Buddington (1970), Markewicz and Dalton (1977), Herman and Monteverde (1989) and Monteverde (in press).

The Beemerville complex intrudes country rocks ranging in age from Proterozoic to Late Ordovician, but crops out primarily within the Middle to Upper Ordovician Martinsburg Formation. Radiometric dating of biotite from the nepheline syenite at Beemerville yields an age of about 435 ± 20 m.y. for the intrusion (Zartman and others, 1967). Ratcliffe (1981) amended this age to 440 m.y.

The primary intrusive bodies at the surface are two nepheline syenite plutons, located along the contact between the Martinsburg and Shawangunk Formations, and a nearby diatreme within the Martinsburg. Other intrusive bodies include phonolite, tinguaite and lamprophyre dikes, diatremes, and possibly sills. Maxey (1976) proposed a petrogenetic origin for the intrusive complex which involved immiscibility and the fractional crystallization of a carbonate parent magma of basic composition. The complex is probably post-tectonic relative to the deformation of Ordovician rocks (Ratcliffe, 1981). Ordovician deformation in the vicinity of the Beemerville complex is characterized by open, upright folds within the Kittatinny Supergroup and Martinsburg Formation (Herman and Monteverde, 1989). Subsequent Alleghanian tectonism complicates the structural setting.

## GRAVITY FIELD METHODS

A Lacoste & Romberg microgal gravity meter (model D25) capable of being read to the nearest 0.001 milligal (mGal) was used in this study. Secondary base stations were established at several locations in the area. These were referenced to a primary base station at Princeton University (Bonini and Woollard, 1957) with repeated loops.

Gravity readings were taken mainly on bench marks, road intersections or along roads. Station elevations and latitudes were obtained from U.S. Geological Survey 7.5-minute quadrangle maps with a contour interval of 20 feet. The margins of error in station location are ± 10 ft (3 m) elevation and ± 0.025 minutes latitude. The gravity observations are accurate to approximately ± 0.6 mGal due to instrument, elevation and latitude inaccuracy.

Gravity observations by Spink (written communication, 1986) were taken using a Lacoste-Romberg gravimeter (model G133). The station elevations were determined using a Wallace and Tiernan altimeter referenced to benchmarks.

## GRAVITY DATA REDUCTION

Gravity observations at each station were corrected for instrumental drift, tide, latitude and elevation effects using standard formulas from Dobrin (1976). The International Gravity Formula of 1930 (Dobrin, 1976) was used to determine the theoretical gravity at sea level at a given latitude. A density of 2.67 g/cm$^3$ was used for Bouguer corrections.

Terrain corrections, which account for the deviation of topography from a horizontal surface, were calculated using a two-dimensional terrain correction computer program. This program calculates the vertical component of the gravity anomaly using the line-integral algorithm of Talwani and others (1959). Removal of the vertical component of gravity from the Bouguer slab effect (Dobrin, 1976) results in an approximation of the terrain-correction value. Gravity terrain-correction values were calculated along 17 parallel profiles oriented north-northwest—south-southeast, with stations at 1640-foot (500-meter) intervals. Profiles were 1.9 miles (3 km) apart. The terrain-correction values were plotted and contoured to obtain a gravity terrain-correction map. Terrain corrections of several stations on one profile were determined using a Hammer graticule (Hammer, 1939) to verify the two-dimensional method. The correction-factor difference between the two techniques ranged from 0.4 to -0.1 mGals. The terrain-correction factor for each gravity station was interpolated from the terrain-correction map and was added to the gravity value to obtain the Bouguer gravity anomaly. The terrain corrections ranged in value from 0.07 to 2.0 mGals.

The Bouguer gravity anomaly values (table 2) were then plotted and contoured to obtain a Bouguer gravity anomaly map (fig. 1).

## GRAVITY DATA ANALYSIS

The Bouguer gravity values were analyzed using the double Fourier series analysis program of James (1966). This program is used for trend-surface analysis of irregularly spaced data. A trend surface approximates the regional gravity. With the first harmonic, the program removed from the Bouguer gravity values all wavelengths in excess of 33 miles (53 km) in the north-south direction and 27.5 miles (44 km) in the east-west direction. The residual gravity values thus obtained were then plotted and contoured to obtain the residual gravity map (fig. 2).

A two-dimensional, nonlinear, least-squares gravity inversion program was used to model the Bouguer gravity data in profile form. This program incorporates the Marquardt procedure (Beck and Arnold, 1977) to calculate and optimize new parameters for each iteration of the model. A straight-line regional gravity gradient was also calculated. The gravity field of the initial model was calculated using the line integral algorithm of Talwani and others (1959). Three profiles (fig. 1) were modeled. The interpretation of gravity anomalies is not unique, hence requires some constraints in the modeling process. In this case the surface geology and the density contrasts of the outcropping geologic units were constrained. The depths to Middle Proterozoic gneissic and granitoid basement and Paleozoic sedimentary units were extrapolated from the surface geologic structure. Thicknesses were from nearby measured sections. Densities were adapted from Dobrin (1976), Telford and others (1976), and from rock sample measurements. These were contrasted with the assumed density of Middle Proterozoic basement of 2.67 g/cm$^3$. Density contrasts (g/cm$^3$) are:

| | |
|---|---|
| Quaternary glacial sediments | - 0.67 |
| Devonian sedimentary rocks | 0.03 |
| Silurian quartzite/conglomerate | - 0.02 |
| Ordovician slate and greywacke | 0.00 |
| Cambrian and Ordovician carbonates | 0.03 |
| Ordovician intrusives undifferentiated | 0.13 |
| Volcanic breccia; other volcanics | 0.25 |
| Mafic rocks | 0.055-0.194 |
| Proterozoic granitic basement | 0.00 |

## RESULTS AND INTERPRETATION

The Bouguer gravity anomaly map and the residual gravity map show a closed gravity high in the vicinity of the Beemerville intrusive complex outcrop. An aeromagnetic high is also visible in the same area (fig. 3). The gravity high results from the contrast between intrusive bodies and the lower density Paleozoic sedimentary rocks. The gradient of the gravity closure is gentle in the southeast and steeper in the northwest, suggesting a southeasterly dip of the intrusive body. A second gravity high in the Harmonyvale-Lewisburg area may be due to a part of the Beemerville intrusive or to a change in Proterozoic rock density in the subsurface.

Gravity profile A-A' (fig. 4), trending northwest-southeast through the gravity high at Beemerville, was modeled as shown. This model shows the Beemerville intrusive to be dipping to the southeast. It is thin near the surface and thickens with depth. In the model, another high-density body, an intrusive, accounts for the gravity high northwest of Beaver Run in the Harmonyvale-Lewisburg area. The presence of an aeromagnetic high in the same area (fig. 3) is consistent with this interpretation. A basement high and an anticlinal structure corresponding to a thrust fault mapped at the surface are interpreted for the Beaver Run area. Middle Proterozoic rocks crop out at the southeastern end of the profile near Hardystonville. Faulting within the Proterozoic and Paleozoic rocks has been included in the model and account for the irregularity of the OЄjk and Y contacts in the profiles. Paleozoic rock within the fault block accounts for the gravity low.

A northeast-southwest trending gravity high in the Lake Owassa-Culvers Lake area, southwest of the gravity high in the Beemervile area, shows as an extension of the Beemerville anomaly on the Bouguer gravity anomaly map and as a separate anomaly on the residual gravity map. This anomaly may result from an extension of the Beemerville intrusive body, a separate pluton, or it may result from high-density Proterozoic rock. Coincidence of part of this gravity high with a high in the aeromagnetic map is consistent with either interpretation.

An elongate Bouguer gravity low (fig. 1) in the Swartswood-Branchville area appears as a residual closed gravity low (fig. 2). This is attributed to an anticline along which Cambrian-Ordovician carbonates are exposed to the southwest. At Branchville the carbonates plunge beneath Ordovician slate, sandstone and graywacke. This gravity low can be attributed either to the lower density of carbonate rocks as compared to the surrounding rocks or to lower density Proterozoic basement rock near the surface beneath the anticline.

The model for gravity profile B-B' (fig. 5), through this anomaly, includes a faulted anticlinal structure based on surface mapping and cross sections by Herman and Monteverde (1989). The gravity high in the southeastern part of the profile, in the Newton area, has been interpreted as a high-density Proterozoic basement rock, which may be amphibolite or pyroxene gneiss (2.9 g/cm$^3$). Consistent with this, the aeromagnetic map shows an anomaly (high) in the same area. High frequency anomalies within the gravity low are attributed by the model to very low density glacial deposits. The gravity high at the northwestern end of the profile is interpreted to result from an intrusive body having a density contrast equal to that of the Beemerville complex intrusive body. No geologic evidence at the land surface supports this intrusive body, perhaps because glacial material covers the bedrock. An alternative model which could account for this gravity high involves a higher density Proterozoic rock underlying the carbonate sequence, but this model does not adequately fit the gravity data along profile C-C' (fig. 6).

Profile C-C', along geologic strike, intersects gravity profiles A-A' and B-B'. The model shows the Paleozoic sedimentary rocks deepening and thickening to the northeast. As along profile A-A', the nepheline syenite and the volcanic breccia intrusives produce the gravity high near Branchville. The southwestern end of the gravity profile, crossing profile B-B', is flat. The model shows the flat response to be caused by a separate pluton or an extension of the intrusive body. In the absence of a high-density body the profile would have been a steep gradiant. The alternative model for profile B-B', a high-density Proterozoic rock underlying the carbonate sequence, would not produce a flat gravity response on C-C' and therefore cannot be accepted.

Away from the profiles, the north-northeast—south-southwest trending series of residual gravity lows (fig. 2) from Wantage in the north-northeast to Houses Corner in the south-southwest may be due to moderate- to high-angle faults involving Proterozoic and Cambrian-Ordovician rocks as modeled in profile A-A' (fig. 4). The residual gravity high in the Quarryville area may be due to outcropping Ordovician carbonates overlying high-density Proterozoic rocks. The east-west trending residual gravity lows north of Beemerville near Colesville may be caused by the abrupt change in density at the contact between the high-density Beemerville intrusion and lower-density Silurian and Ordovician sediments. Some of the anomalies along the edges of the residual gravity map may be due to sparse data coverage and edge effects of processing.

## SUMMARY

Gravity data have been analyzed using double Fourier series trend surface analysis, then modeled using two-dimensional gravity inversion techniques with surface geologic constraints. Aeromagnetic anomalies are closely associated with the gravity anomalies and were used in their interpretation.

A closed gravity high is associated with the Beemerville intrusive complex, resulting from the higher density of the intrusives as compared to the host Paleozoic sedimentary rocks. The Beemerville intrusive complex appears to extend to the southwest. Two-dimensional modeling shows that the intrusive is elongate in shape and dips nearly vertically to the southeast. Paleozoic sedimentary rocks appear to deepen and thicken from south to north within the study area. A series of north-northeast—south-southwest trending gravity lows within the New Jersey Highlands results from downfaulting of Paleozoic sedimentary rocks into areas of Proterozoic rock.

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### Table 2. Gravity data [1]

| Station No. | Latitude deg. | Latitude min. | Longitude deg. | Longitude min. | Observed gravity (mGal) | Terrain correction | Bouguer gravity (mGal) |
|---|---|---|---|---|---|---|---|
| 1 | 41 | 13.570 | 74 | 41.820 | 980194.9 | 0.6 | -37.3 |
| 2 | 41 | 14.030 | 74 | 42.750 | 980181.0 | 0.0 | -40.6 |
| 3 | 41 | 13.910 | 74 | 42.650 | 980169.2 | 1.5 | -38.7 |
| 4 | 41 | 13.910 | 74 | 42.390 | 980164.7 | 1.0 | -39.6 |
| 5 | 41 | 13.090 | 74 | 42.260 | 980168.1 | 0.3 | -38.5 |
| 6 | 41 | 13.730 | 74 | 42.140 | 980175.7 | 0.9 | -38.2 |
| 7 | 41 | 13.610 | 74 | 41.970 | 980187.4 | 0.7 | -37.8 |
| 8 | 41 | 13.250 | 74 | 41.730 | 980202.3 | 0.4 | -36.3 |
| 9 | 41 | 13.110 | 74 | 41.480 | 980209.0 | 0.3 | -36.5 |
| 10 | 41 | 12.640 | 74 | 41.420 | 980205.3 | 0.2 | -37.2 |
| 11 | 41 | 12.440 | 74 | 40.600 | 980203.1 | 0.2 | -37.8 |
| 12 | 41 | 13.940 | 74 | 41.190 | 980193.6 | 0.9 | -36.8 |
| 13 | 41 | 13.670 | 74 | 40.950 | 980203.8 | 0.6 | -36.9 |
| 14 | 41 | 13.660 | 74 | 40.460 | 980208.3 | 0.4 | -38.3 |
| 15 | 41 | 14.280 | 74 | 40.440 | 980203.4 | 0.5 | -38.8 |
| 16 | 41 | 14.330 | 74 | 40.940 | 980193.3 | 0.6 | -38.8 |
| 17 | 41 | 14.210 | 74 | 41.420 | 980183.8 | 0.8 | -37.7 |
| 18 | 41 | 14.500 | 74 | 41.080 | 980101.3 | 0.7 | -39.4 |
| 19 | 41 | 14.940 | 74 | 40.910 | 980183.6 | 0.6 | -40.5 |
| 20 | 41 | 15.030 | 74 | 39.980 | 980203.0 | 0.3 | -41 |
| 21 | 41 | 13.100 | 74 | 40.300 | 980210.9 | 0.3 | -38.2 |
| 22 | 41 | 12.900 | 74 | 39.490 | 980213.4 | 0.2 | -38.8 |
| 23 | 41 | 12.350 | 74 | 38.750 | 980215.4 | 0.2 | -38.6 |
| 24 | 41 | 13.870 | 74 | 38.290 | 980207.2 | 0.2 | -40.1 |
| 25 | 41 | 14.370 | 74 | 39.290 | 981206.9 | 0.2 | -40.1 |
| 26 | 41 | 13.950 | 74 | 39.830 | 980204.6 | 0.3 | -39.1 |
| 27 | 41 | 13.560 | 74 | 42.650 | 980164.6 | 0.9 | -39 |
| 28 | 41 | 13.540 | 74 | 42.440 | 980174.2 | 0.8 | -38.8 |
| 29 | 41 | 13.310 | 74 | 42.510 | 980181.6 | 0.6 | -38.4 |
| 30 | 41 | 13.160 | 74 | 42.410 | 980192.2 | 0.4 | -37.3 |
| 31 | 41 | 12.910 | 74 | 42.040 | 980203.1 | 0.3 | -37.6 |
| 32 | 41 | 12.550 | 74 | 42.210 | 980201.5 | 0.2 | -37.8 |
| 33 | 41 | 12.200 | 74 | 42.950 | 980200.5 | 0.3 | -38.4 |
| 34 | 41 | 12.460 | 74 | 42.950 | 980197.7 | 0.3 | -38.7 |
| 35 | 41 | 12.570 | 74 | 43.390 | 980192.0 | 0.7 | -38.8 |
| 36 | 41 | 11.940 | 74 | 41.630 | 980204.7 | 0.2 | -37.8 |
| 37 | 41 | 11.160 | 74 | 42.400 | 980202.2 | 0.2 | -38.3 |
| 38 | 41 | 10.430 | 74 | 42.040 | 980204.1 | 0.2 | -39.1 |
| 39 | 41 | 9.800 | 74 | 41.200 | 980214.3 | 0.3 | -39.1 |
| 40 | 41 | 11.210 | 74 | 40.900 | 980205.5 | 0.2 | -38.6 |
| 41 | 41 | 11.720 | 74 | 39.920 | 980205.7 | 0.2 | -38.9 |
| 42 | 41 | 12.300 | 74 | 41.500 | 980203.6 | 0.2 | -37.2 |
| 43 | 41 | 12.690 | 74 | 41.870 | 980203.0 | 0.2 | -37.5 |
| 44 | 41 | 12.340 | 74 | 41.590 | 980204.6 | 0.2 | -37.7 |
| 45 | 41 | 8.670 | 74 | 45.360 | 980200.4 | 0.3 | -43.1 |
| 46 | 41 | 11.080 | 74 | 47.860 | 980191.0 | 0.5 | -43.8 |
| 47 | 41 | 12.050 | 74 | 49.180 | 980211.6 | 0.4 | -44 |
| 48 | 41 | 12.900 | 74 | 49.650 | 980211.0 | 0.1 | -45.3 |
| 49 | 41 | 13.800 | 74 | 50.540 | 980203.2 | 0.1 | -45.9 |
| 50 | 41 | 14.880 | 74 | 50.840 | 980215.8 | 0.1 | -47.7 |
| 51 | 41 | 11.880 | 74 | 43.150 | 980202.1 | 0.3 | -37.9 |
| 52 | 41 | 10.830 | 74 | 44.090 | 980204.5 | 0.2 | -38.9 |
| 53 | 41 | 9.600 | 74 | 44.270 | 980202.7 | 0.3 | -41.1 |
| 54 | 41 | 10.020 | 74 | 43.080 | 980204.8 | 0.2 | -39.9 |
| 55 | 41 | 10.950 | 74 | 43.090 | 980203.6 | 0.2 | -38.5 |
| 56 | 41 | 11.240 | 74 | 43.740 | 980205.3 | 0.3 | -38.8 |
| 57 | 41 | 10.890 | 74 | 45.080 | 980193.6 | 0.3 | -39.8 |
| 58 | 41 | 11.790 | 74 | 44.060 | 980192.1 | 0.8 | -39 |
| 59 | 41 | 8.630 | 74 | 42.410 | 980208.7 | 0.2 | -42 |
| 60 | 41 | 9.490 | 74 | 43.400 | 980207.2 | 0.2 | -40.7 |
| 61 | 41 | 9.240 | 74 | 43.960 | 980195.2 | 0.3 | 40.9 |
| 62 | 41 | 9.070 | 74 | 44.820 | 980205.7 | 0.3 | 41.7 |
| 63 | 41 | 10.110 | 74 | 46.020 | 980190.6 | 0.3 | -42 |
| 64 | 41 | 8.340 | 74 | 46.260 | 980188.3 | 0.3 | -43.8 |
| 65 | 41 | 7.540 | 74 | 47.530 | 980182.0 | 0.1 | -45.1 |
| 66 | 41 | 6.390 | 74 | 47.350 | 980199.2 | 0.3 | -46.3 |
| 67 | 41 | 6.300 | 74 | 46.050 | 980197.8 | 0.3 | -46.5 |
| 68 | 41 | 5.860 | 74 | 45.000 | 980196.9 | 0.1 | -44.7 |
| 69 | 41 | 6.960 | 74 | 44.390 | 980205.1 | 0.1 | -43.9 |
| 70 | 41 | 7.240 | 74 | 45.080 | 980205.5 | 0.3 | -44.6 |
| 71 | 41 | 7.740 | 74 | 45.640 | 980201.4 | 0.4 | -44.4 |
| 72 | 41 | 14.660 | 74 | 44.060 | 980193.4 | 0.4 | -42.9 |
| 73 | 41 | 13.860 | 74 | 45.800 | 980202.1 | 0.4 | -42.5 |
| 74 | 41 | 13.530 | 74 | 45.010 | 980200.0 | 0.4 | -42.7 |
| 75 | 41 | 14.620 | 74 | 36.110 | 980205.0 | 0.3 | -41.4 |
| 76 | 41 | 13.710 | 74 | 36.820 | 980220.8 | 0.2 | -39.3 |
| 77 | 41 | 11.590 | 74 | 34.260 | 980217.4 | 0.3 | -42.8 |
| 78 | 41 | 17.270 | 74 | 45.790 | 980204.6 | 0.4 | -43.9 |
| 79 | 41 | 16.450 | 74 | 45.470 | 980184.8 | 0.5 | -42.5 |
| 80 | 41 | 15.970 | 74 | 44.740 | 980174.8 | 0.5 | -43 |
| 81 | 41 | 14.850 | 74 | 45.590 | 980182.6 | 0.6 | -43 |
| 82 | 41 | 13.030 | 74 | 47.320 | 980207.9 | 0.3 | -43.5 |
| 83 | 41 | 12.360 | 74 | 46.510 | 980196.6 | 0.4 | -42.7 |
| 84 | 41 | 15.700 | 74 | 46.450 | 980198.5 | 0.5 | -43.5 |
| 85 | 41 | 15.910 | 74 | 48.090 | 980206.9 | 0.2 | -44.6 |
| 86 | 41 | 14.310 | 74 | 48.220 | 980209.5 | 0.3 | -43.5 |
| 87 | 41 | 15.810 | 74 | 49.740 | 980220.2 | 0.3 | -45.1 |
| 88 | 41 | 16.690 | 74 | 49.420 | 980220.9 | 0.2 | -45.1 |
| 89 | 41 | 18.050 | 74 | 47.700 | 980219.7 | 0.3 | -44.9 |
| 90 | 41 | 18.960 | 74 | 46.550 | 980222.6 | 0.3 | -44.8 |
| 91 | 41 | 18.780 | 74 | 44.520 | 980215.6 | 0.3 | -44.1 |
| 92 | 41 | 19.630 | 74 | 42.790 | 980220.4 | 0.7 | -42.9 |
| 93 | 41 | 19.980 | 74 | 44.810 | 980227.0 | 0.2 | -44 |
| 94 | 41 | 15.550 | 74 | 42.900 | 980183.8 | 0.3 | -42.5 |
| 95 | 41 | 16.290 | 74 | 41.840 | 980182.2 | 0.5 | -43 |
| 96 | 41 | 16.940 | 74 | 42.930 | 980176.5 | 0.4 | -43.3 |
| 97 | 41 | 18.310 | 74 | 42.380 | 980179.7 | 0.6 | -43.9 |
| 98 | 41 | 17.530 | 74 | 41.390 | 980179.3 | 0.7 | -42.8 |
| 99 | 41 | 19.700 | 74 | 39.500 | 980163.4 | 1.6 | -42.1 |
| 100 | 41 | 19.000 | 74 | 38.860 | 980192.4 | 0.9 | -41.2 |
| 101 | 41 | 18.760 | 74 | 36.620 | 980210.4 | 0.0 | -40.5 |
| 102 | 41 | 18.070 | 74 | 34.820 | 980218.2 | 0.0 | -39.4 |
| 103 | 41 | 11.920 | 74 | 35.530 | 980222.2 | 0.2 | -40.2 |
| 104 | 41 | 14.370 | 74 | 32.580 | 980219.0 | 0.5 | -44.6 |
| 105 | 41 | 10.720 | 74 | 32.390 | 980215.5 | 0.5 | -43.1 |
| 106 | 41 | 9.210 | 74 | 34.590 | 980213.4 | 0.4 | -41.9 |
| 107 | 41 | 13.390 | 74 | 34.750 | 980222.8 | 0.3 | -41.3 |
| 108 | 41 | 15.090 | 74 | 34.390 | 980217.7 | 0.4 | -41.4 |
| 109 | 41 | 16.990 | 74 | 36.590 | 980211.2 | 0.3 | -42.8 |
| 110 | 41 | 17.410 | 74 | 38.030 | 980199.9 | 0.4 | -42.8 |
| 111 | 41 | 11.320 | 74 | 37.060 | 980212.4 | 0.2 | -39 |
| 112 | 41 | 10.540 | 74 | 38.080 | 980220.3 | 0.2 | -38.6 |
| 113 | 41 | 9.980 | 74 | 39.180 | 980218.1 | 0.2 | -38.3 |
| 114 | 41 | 9.520 | 74 | 38.530 | 980208.2 | 0.1 | -39.2 |
| 115 | 41 | 9.150 | 74 | 37.310 | 980215.9 | 0.1 | -38.7 |
| 116 | 41 | 9.100 | 74 | 35.630 | 980209.9 | 0.2 | -41.9 |
| 117 | 41 | 8.950 | 74 | 32.730 | 980199.9 | 0.6 | -44.1 |
| 118 | 41 | 7.980 | 74 | 34.530 | 980205.2 | 0.2 | -42.4 |
| 119 | 41 | 7.320 | 74 | 35.720 | 980206.5 | 0.1 | -42.7 |
| 120 | 41 | 7.660 | 74 | 31.490 | 980200.0 | 0.1 | -41 |
| 121 | 41 | 8.880 | 74 | 39.890 | 980212.1 | 0.1 | -39 |
| 122 | 41 | 8.160 | 74 | 38.920 | 980208.1 | 0.1 | -38.5 |
| 123 | 41 | 7.860 | 74 | 38.220 | 980207.6 | 0.2 | -38.2 |
| 124 | 41 | 7.660 | 74 | 37.370 | 980207.4 | 0.2 | -40.7 |
| 125 | 41 | 5.800 | 74 | 37.650 | 980197.3 | 0.4 | -43 |
| 126 | 41 | 5.280 | 74 | 36.590 | 980193.3 | 0.2 | -40.5 |
| 127 | 41 | 4.760 | 74 | 35.510 | 980191.4 | 0.5 | -41.1 |
| 128 | 41 | 4.200 | 74 | 34.870 | 980174.5 | 0.6 | -39.5 |
| 129 | 41 | 3.600 | 74 | 34.300 | 980165.3 | 0.3 | -35.3 |
| 130 | 41 | 2.810 | 74 | 33.230 | 980171.2 | 0.2 | -34.9 |
| 131 | 41 | 2.510 | 74 | 37.850 | 980194.0 | 0.3 | -40.1 |
| 132 | 41 | .900 | 74 | 40.150 | 980204.8 | 0.1 | -41.5 |
| 133 | 41 | .210 | 74 | 36.360 | 980197.2 | 0.4 | -41.4 |
| 134 | 41 | 5.980 | 74 | 34.840 | 980202.4 | 0.3 | -41.7 |
| 135 | 41 | .430 | 74 | 36.450 | 980190.4 | 0.3 | -41.6 |
| 136 | 41 | 1.280 | 74 | 49.870 | 980186.2 | 0.2 | -41.7 |
| 137 | 41 | .300 | 74 | 51.380 | 980183.4 | 0.1 | -41.8 |
| 138 | 41 | 4.190 | 74 | 53.300 | 980178.4 | 1.5 | -43.5 |
| 139 | 41 | 2.960 | 74 | 52.960 | 980192.1 | 0.4 | -46.1 |
| 140 | 41 | 2.140 | 74 | 52.820 | 980197.3 | 0.4 | -48 |
| 141 | 41 | 1.480 | 74 | 51.820 | 980197.1 | 0.2 | -45 |
| 142 | 41 | 3.550 | 74 | 45.250 | 980196.3 | 0.2 | -40.2 |
| 143 | 41 | 0.090 | 74 | 41.280 | 980181.2 | 0.2 | -39.1 |
| 144 | 41 | 1.150 | 74 | 41.420 | 980184.3 | 0.2 | -40.3 |
| 145 | 41 | 2.120 | 74 | 42.070 | 980193.8 | 0.2 | -41.6 |
| 146 | 41 | 2.490 | 74 | 43.280 | 980195.7 | 0.1 | -40.3 |
| 147 | 41 | 7.350 | 74 | 51.800 | 980178.1 | 0.4 | -43.7 |
| 148 | 41 | 6.220 | 74 | 51.090 | 980187.2 | 0.4 | -43.5 |
| 149 | 41 | 5.430 | 74 | 50.030 | 980191.5 | 0.3 | -45.1 |
| 150 | 41 | 4.860 | 74 | 49.000 | 980199.4 | 0.2 | -46.9 |
| 151 | 41 | 4.880 | 74 | 48.540 | 980198.4 | 0.3 | -46.4 |
| 152 | 41 | 4.390 | 74 | 48.190 | 980195.7 | 0.2 | -46.6 |
| 153 | 41 | 4.370 | 74 | 47.690 | 980201.1 | 0.2 | -45.6 |
| 154 | 41 | 4.140 | 74 | 47.560 | 980200.9 | 0.2 | -44.8 |
| 155 | 41 | 4.170 | 74 | 47.420 | 980197.2 | 0.2 | -44.2 |
| 156 | 41 | 3.780 | 74 | 46.450 | 980191.3 | 0.2 | -41.9 |
| 157 | 41 | 3.920 | 74 | 47.470 | 980193.0 | 0.2 | -43.6 |
| 158 | 41 | 4.450 | 74 | 47.830 | 980201.5 | 0.2 | -46.2 |
| 159 | 41 | 4.430 | 74 | 47.960 | 980200.0 | 0.2 | -46.3 |
| 160 | 41 | 4.540 | 74 | 48.270 | 980195.2 | 0.2 | -46.5 |
| 161 | 41 | 4.720 | 74 | 48.340 | 980199.7 | 0.2 | -45.2 |
| 162 | 41 | 4.870 | 74 | 48.740 | 980198.9 | 0.3 | -46.3 |
| 163 | 41 | 4.960 | 74 | 49.220 | 980199.9 | 0.3 | -46.9 |
| 164 | 41 | 5.020 | 74 | 49.460 | 980200.8 | 0.3 | -45.8 |
| 165 | 41 | 5.130 | 74 | 49.750 | 980199.2 | 0.3 | -45.8 |
| 166 | 41 | 5.340 | 74 | 49.780 | 980195.7 | 0.3 | -45.3 |
| 167 | 41 | 5.700 | 74 | 50.500 | 980186.6 | 0.1 | -44.7 |
| 168 | 41 | 7.650 | 74 | 43.480 | 980207.6 | 0.1 | -43.1 |
| 169 | 41 | 7.830 | 74 | 43.960 | 980205.4 | 0.1 | -43.9 |
| 170 | 41 | 7.890 | 74 | 44.090 | 980206.7 | 0.1 | -43.8 |
| 171 | 41 | 8.010 | 74 | 44.190 | 980206.7 | 0.1 | -44.1 |
| 172 | 41 | 8.270 | 74 | 44.350 | 980207.7 | 0.1 | -43.3 |
| 173 | 41 | 8.490 | 74 | 44.400 | 980206.2 | 0.1 | -43.6 |
| 174 | 41 | 8.530 | 74 | 45.070 | 980202.9 | 0.2 | -43.3 |
| 175 | 41 | 8.830 | 74 | 45.610 | 980200.2 | 0.3 | -43.2 |
| 176 | 41 | 8.970 | 74 | 45.790 | 980199.1 | 0.3 | -42.8 |
| 177 | 41 | 12.3 | 74 | 37.3 | 980223.6 | 0.15 | -39.64 |
| 178 | 41 | 11.867 | 74 | 37.87 | 980222.8 | 0.25 | -39.11 |
| 179 | 41 | 11.5 | 74 | 38.37 | 980220.3 | 0.25 | -40.70 |
| 180 | 41 | 10.867 | 74 | 38.98 | 980218.8 | 0.3 | -38.40 |
| 181 | 41 | 10.533 | 74 | 39.88 | 980217.9 | 0.3 | -39.43 |
| 182 | 41 | 9.817 | 74 | 40.5 | 980218.1 | 0.24 | -37.89 |
| 183 | 41 | 10.3 | 74 | 40.13 | 980217.8 | 0.31 | -38.58 |
| 184 | 41 | 9.267 | 74 | 40.8 | 980215.4 | 0.12 | -39.02 |
| 185 | 41 | 8.933 | 74 | 41.6 | 980214.8 | 0.15 | -40.35 |
| 186 | 41 | 8.333 | 74 | 41.92 | 980209.0 | 0.17 | -40.38 |
| 187 | 41 | 7.983 | 74 | 42.27 | 980207.3 | 0.17 | -42.60 |
| 188 | 41 | 13.6 | 74 | 36.8 | 980221.4 | 0.18 | -40.71 |
| 189 | 41 | 13.6 | 74 | 36.9 | 980220.7 | 0.16 | -41.18 |
| 190 | 41 | 14.033 | 74 | 37.08 | 980218.3 | 0.15 | -41.41 |
| 191 | 41 | 14.483 | 74 | 37.43 | 980219.0 | 0.16 | -41.08 |
| 192 | 41 | 15.683 | 74 | 37.83 | 980217.1 | 0.2 | -41.84 |
| 193 | 41 | 15.1 | 74 | 37.62 | 980218.8 | 0.18 | -41.88 |
| 194 | 41 | 15.85 | 74 | 38.37 | 980212.6 | 0.32 | -41.98 |
| 195 | 41 | 16.183 | 74 | 38.83 | 980205.3 | 0.33 | -41.56 |
| 196 | 41 | 16.6 | 74 | 39.22 | 980203.3 | 0.45 | -42.05 |
| 197 | 41 | 17 | 74 | 39.38 | 980198.0 | 0.75 | -41.35 |
| 198 | 41 | 17.467 | 74 | 39.22 | 980198.5 | 0.9 | -41.72 |
| 199 | 41 | 17.85 | 74 | 39.42 | 980191.8 | 1.34 | -41.31 |
| 200 | 41 | 18.017 | 74 | 39.78 | 980175.1 | 1.4 | -40.76 |
| 201 | 41 | 18.383 | 74 | 40.3 | 980163.0 | 0.85 | -42.19 |
| 202 | 41 | 18.433 | 74 | 40.68 | 980170.1 | 0.82 | -42.50 |
| 203 | 41 | 18.667 | 74 | 40.67 | 980172.3 | 0.95 | -41.77 |
| 204 | 41 | 19.233 | 74 | 40.7 | 980173.5 | 1.25 | -43.46 |
| 205 | 41 | 19.533 | 74 | 40.7 | 980182.5 | 1.28 | -42.88 |
| 206 | 41 | 12.183 | 74 | 36.17 | 980223.8 | 0.18 | -39.73 |
| 207 | 41 | 11.967 | 74 | 35.96 | 980223.0 | 0.19 | -40.22 |
| 208 | 41 | 11.617 | 74 | 35.18 | 980223.2 | 0.22 | -39.26 |
| 209 | 41 | 10.917 | 74 | 35.48 | 980221.0 | 0.17 | -39.52 |
| 210 | 41 | 10.083 | 74 | 35.27 | 980218.4 | 0.17 | -41.53 |
| 211 | 41 | 9.8 | 74 | 35.08 | 980214.9 | 0.18 | -43.81 |
| 212 | 41 | 9.367 | 74 | 34.7 | 980214.4 | 0.25 | -43.72 |
| 213 | 41 | 8.8 | 74 | 34.45 | 980210.3 | 0.29 | -42.55 |
| 214 | 41 | 8.4 | 74 | 34.3 | 980203.9 | 0.32 | -41.86 |
| 215 | 41 | 9.967 | 74 | 74.34 | 980214.5 | 0.49 | -41.45 |
| 216 | 41 | 9.833 | 74 | 33.67 | 980211.6 | 0.45 | -43.00 |
| 217 | 41 | 10 | 74 | 33.32 | 980212.1 | 0.5 | -43.23 |
| 218 | 41 | 10.367 | 74 | 32.05 | 980213.8 | 0.47 | -43.08 |
| 219 | 41 | 2.733 | 74 | 44.5 | 980197.7 | 0.11 | -39.81 |
| 220 | 41 | 3.517 | 74 | 43.48 | 980199.6 | 0.08 | -40.61 |
| 221 | 41 | 3.683 | 74 | 42.95 | 980197.4 | 0.09 | -41.80 |
| 222 | 41 | 3.967 | 74 | 42.63 | 980197.0 | 0.11 | -42.99 |
| 223 | 41 | 4.417 | 74 | 42.12 | 980196.3 | 0.12 | -44.88 |
| 224 | 41 | 4.5 | 74 | 41.48 | 980198.7 | 0.13 | -42.77 |
| 225 | 41 | 4.967 | 74 | 41.07 | 980196.5 | 0.13 | -41.99 |
| 226 | 41 | 5.367 | 74 | 40.8 | 980196.7 | 0.12 | -42.96 |
| 227 | 41 | 5.617 | 74 | 40.23 | 980195.3 | 0.11 | -42,62 |
| 228 | 41 | 5.667 | 74 | 39.65 | 980195.7 | 0.18 | -41.68 |
| 229 | 41 | 5.933 | 74 | 39.1 | 980197.9 | 0.2 | -41.85 |
| 230 | 41 | 6.45 | 74 | 38.6 | 980201.2 | 0.2 | -41.12 |
| 231 | 41 | 6.867 | 74 | 38.07 | 980204.1 | 0.21 | -40.78 |
| 232 | 41 | 12.867 | 74 | 36.05 | 980217.5 | 0.19 | -39.96 |
| 233 | 41 | 13.4 | 74 | 35.62 | 980217.3 | 0.2 | -40.34 |
| 234 | 41 | 13.85 | 74 | 35.28 | 980215.9 | 0.21 | -41.63 |
| 235 | 41 | 14.567 | 74 | 34.87 | 980217.5 | 0.31 | -41.08 |
| 236 | 41 | 15.083 | 74 | 33.92 | 980217.8 | 0.34 | -41.52 |
| 237 | 41 | 15.7 | 74 | 33.33 | 980219.1 | 0.32 | -41.22 |
| 238 | 41 | 16.15 | 74 | 33.58 | 980223.0 | 0.28 | -40.34 |
| 239 | 41 | 16.383 | 74 | 33.4 | 980226.5 | 0.25 | -41.12 |
| 240 | 41 | 17.033 | 74 | 33 | 980229.9 | 0.25 | -40.51 |
| 241 | 41 | 17.633 | 74 | 33.43 | 980225.9 | 0.22 | -40.44 |
| 242 | 41 | 7.655 | 74 | 37.37 | 980207.4 | 0.18 | -40.69 |
| 243 | 41 | 7.929 | 74 | 36.77 | 980206.1 | 0.12 | -41.41 |
| 244 | 41 | 8.18 | 74 | 36.28 | 980204.6 | 0.09 | -40.45 |
| 245 | 41 | 8.417 | 74 | 36.09 | 980208.3 | 0.13 | -41.28 |
| 246 | 41 | 8.948 | 74 | 35.71 | 980208.1 | 0.19 | -41.58 |
| 247 | 41 | 9.135 | 74 | 34.84 | 980215.6 | 0.32 | -41.85 |
| 248 | 41 | 2.433 | 74 | 38.58 | 980187.9 | 0.25 | -39.55 |
| 249 | 41 | 2.95 | 74 | 38.63 | 980192.1 | 0.39 | -40.37 |
| 250 | 41 | 3.4 | 74 | 38.77 | 980187.7 | 0.6 | -40.62 |
| 251 | 41 | 3.85 | 74 | 39.02 | 980196.6 | 0.47 | -40.78 |
| 252 | 41 | 4.4 | 74 | 39.47 | 980197.5 | 0.3 | -43.36 |
| 253 | 41 | 4.7 | 74 | 39.82 | 980196.1 | 0.2 | -42.89 |
| 254 | 41 | 5.033 | 74 | 40.23 | 980197.7 | 0.13 | -42.65 |
| 255 | 41 | 5.717 | 74 | 41.18 | 980200.6 | 0.13 | -42.64 |
| 256 | 41 | 5.983 | 74 | 41.5 | 980204.1 | 0.13 | -42.26 |
| 257 | 41 | 6.35 | 74 | 41.92 | 980205.0 | 0.13 | -41.47 |
| 258 | 41 | 6.7 | 74 | 42.4 | 980204.2 | 0.09 | -42.99 |
| 259 | 41 | 7.2 | 74 | 42.8 | 980206.5 | 0.15 | -42.67 |
| 260 | 41 | 7.45 | 74 | 43.15 | 980206.8 | 0.16 | -42.82 |
| 261 | 41 | 7.73 | 74 | 43.7 | 980208.2 | 0.17 | -42.56 |
| 262 | 41 | 8.23 | 74 | 44.35 | 980207.8 | 0.28 | -42.92 |
| 263 | 41 | 8.47 | 74 | 44.53 | 980207.6 | 0.32 | -42.45 |
| 264 | 41 | 8.87 | 74 | 45.62 | 980198.4 | 0.31 | -43.03 |
| 265 | 41 | 9.9 | 74 | 47.38 | 980190.1 | 0.32 | -42.26 |
| 266 | 41 | 9.067 | 74 | 45.9 | 980199.2 | 0.2 | -43.61 |
| 267 | 41 | 9.233 | 74 | 46.33 | 980194.9 | 0.17 | -42.85 |
| 268 | 41 | 10.533 | 74 | 47.38 | 980187.3 | 0.81 | -43.14 |
| 269 | 41 | 9.433 | 74 | 46.95 | 980189.3 | 0.15 | -43.62 |
| 270 | 41 | 11.883 | 74 | 48.22 | 980208.5 | 0.21 | -43.58 |
| 271 | 41 | 11.05 | 74 | 47.3 | 980191.3 | 0.35 | -43.53 |
| 272 | 41 | 10.75 | 74 | 47.3 | 980185.3 | 0.78 | -42.06 |
| 273 | 41 | 11.05 | 74 | 46.97 | 980186.2 | 0.8 | -40.86 |
| 274 | 41 | 11.117 | 74 | 46.78 | 980188.6 | 0.75 | -41.55 |
| 275 | 41 | 11.4 | 74 | 46.32 | 980179.8 | 0.75 | -41.09 |
| 276 | 41 | 11.517 | 74 | 46.08 | 980175.7 | 0.8 | -42.32 |
| 277 | 41 | 11.983 | 74 | 45.27 | 980169.4 | 0.85 | -41.15 |
| 278 | 41 | 12.317 | 74 | 44.63 | 980162.9 | 0.85 | -39.13 |
| 279 | 41 | 12.667 | 74 | 44.08 | 980163.8 | 1.0 | -39.34 |
| 280 | 41 | 12.833 | 74 | 43.82 | 980163.7 | 1.5 | -40.69 |
| 281 | 41 | 15.467 | 74 | 44.13 | 980183.4 | 0.3 | -42.07 |
| 282 | 41 | 15.067 | 74 | 44 | 980182.7 | 0.32 | -42.95 |
| 283 | 41 | 14.667 | 74 | 44.03 | 980193.5 | 0.37 | -42.27 |
| 284 | 41 | 14.217 | 74 | 44.08 | 980195.6 | 0.39 | -42.31 |
| 285 | 41 | 13.967 | 74 | 43.52 | 980191.3 | 0.75 | -40.00 |
| 286 | 41 | 13.8 | 74 | 43.2 | 980183.1 | 2.0 | -38.13 |
| 287 | 41 | 13.283 | 74 | 43.45 | 980176.7 | 1.8 | -38.39 |
| 288 | 41 | 6.917 | 74 | 43.17 | 980205.4 | 0.09 | -42.50 |
| 289 | 41 | 6.617 | 74 | 43.47 | 980205.8 | .09 | -43.23 |
| 290 | 41 | 6.383 | 74 | 43.62 | 980201.5 | .09 | -43.00 |
| 291 | 41 | 6.017 | 74 | 43.82 | 980196.9 | .09 | -44.43 |
| 292 | 41 | 5.567 | 74 | 43.95 | 980197.1 | .09 | -42.36 |
| 293 | 41 | 5.267 | 74 | 43.88 | 980196.9 | .08 | -42.33 |
| 294 | 41 | 5.033 | 74 | 43.05 | 980196.9 | .08 | -41.8 |
| 295 | 41 | 4.633 | 74 | 44.28 | 980198.0 | .08 | -41.33 |
| 296 | 41 | 3.917 | 74 | 44.87 | 980197.7 | .07 | -41.04 |
| 297 | 41 | 16.25 | 74 | 39.57 | 980199.2 | 0.35 | -41.42 |
| 298 | 41 | 15.85 | 74 | 39.93 | 980193.9 | 0.32 | -41.14 |
| 299 | 41 | 15.567 | 74 | 40.41 | 980190.3 | 0.3 | -41.82 |
| 300 | 41 | 15.317 | 74 | 41.05 | 980167.3 | 1.0 | -41.70 |
| 301 | 41 | 15.133 | 74 | 41.88 | 980180.1 | 0.7 | -41.08 |
| 302 | 41 | 15.467 | 74 | 42.38 | 980187.7 | 0.28 | -42.32 |
| 303 | 41 | 15.617 | 74 | 43.1 | 980185.9 | 0.28 | -42.78 |
| 304 | 41 | 15.85 | 74 | 43.42 | 980181.2 | 0.28 | -43.33 |
| 305 | 41 | 15.633 | 74 | 43.82 | 980184.7 | 0.3 | -42.48 |
| 306 | 41 | 16.967 | 74 | 38.8 | 980201.4 | 0.35 | -40.91 |
| 307 | 41 | 17.417 | 74 | 38.47 | 980203.5 | 0.41 | -41.75 |
| 308 | 41 | 18.217 | 74 | 37.93 | 980199.2 | 0.4 | -41.69 |
| 309 | 41 | 18.867 | 74 | 37.22 | 980203.6 | 0.4 | -41.59 |
| 310 | 41 | 15.9 | 74 | 39.03 | 980204.5 | 0.32 | -41.37 |
| 311 | 41 | 15.683 | 74 | 39.27 | 980204.7 | 0.31 | -42.03 |
| 312 | 41 | 15.45 | 74 | 39.5 | 980199.9 | 0.28 | -41.25 |
| 313 | 41 | 15.283 | 74 | 39.68 | 980201.3 | 0.27 | -40.90 |
| 314 | 41 | 15.117 | 74 | 39.87 | 980205.0 | 0.29 | -40.94 |
| 315 | 41 | 14.967 | 74 | 40.15 | 980203.0 | 0.31 | -40.87 |
| 316 | 41 | 14.85 | 74 | 40.38 | 980202.1 | 0.35 | -40.66 |
| 317 | 41 | 2.083 | 74 | 48.98 | 980190.1 | 0.15 | -41.62 |
| 318 | 41 | 2.617 | 74 | 50.87 | 980197.2 | 0.18 | -46.09 |
| 319 | 41 | 3.35 | 74 | 51.73 | 980197.7 | 0.5 | -46.43 |
| 320 | 41 | 5.117 | 74 | 51.92 | 980183.7 | 1.05 | -43.49 |
| 321 | 41 | 4.483 | 74 | 50.43 | 980199.7 | 0.45 | -45.12 |
| 322 | 41 | 7.383 | 74 | 49.07 | 980181.2 | 0.13 | -43.59 |
| 323 | 41 | 9.533 | 74 | 52.88 | 980208.2 | 0.42 | -47.37 |
| 324 | 41 | 11.267 | 74 | 51.05 | 980213.8 | 0.18 | -46.52 |
| 325 | 41 | 10.55 | 74 | 50.45 | 980189.9 | 0.6 | -44.41 |
| 326 | 41 | 8.517 | 74 | 50.37 | 980185.2 | 0.31 | -43.03 |
| 327 | 41 | 9.133 | 74 | 49.23 | 980186.7 | 0.41 | -42.95 |
| 328 | 41 | 15.617 | 74 | 36.87 | 980208.6 | 0.29 | -41.28 |
| 329 | 41 | 16.8 | 74 | 37.17 | 980219.7 | 0.34 | -42.21 |
| 330 | 41 | 17.133 | 74 | 35.35 | 980210.9 | 0.17 | -42.19 |
| 331 | 41 | 16.617 | 74 | 34.35 | 980213.0 | 0.2 | -41.46 |
| 332 | 41 | 12.5 | 74 | 36.45 | 980223.0 | 0.18 | -39.22 |

[1] a density of 2.67 g/cm$^3$ was used for bouguer corrections

## MAP SYMBOLS

FIGURE 1

| | |
|---|---|
| - - 41 — | **Bouguer gravity contour** - interval 1 mGal; dashed where inferred |
| ■ 203 | **Gravity station** |
| ● 162 | **Gravity station** - from Spink, 1986 |
| ——— | **Geologic contact** |
| ━━━ | **Fault** |
| — — — | **Fold** |

| System | Symbol | Unit | | |
|---|---|---|---|---|
| QUATERNARY | Qu | **undifferentiated** (profile only) | | |
| DEVONIAN | Du | **undifferentiated** | | |
| SILURIAN | Su | **undifferentiated** | | |
| ORDOVICIAN | Ons | **nepheline syenite** | Oiu | **Beemerville intrusives undifferentiated** (profile only) |
| | Ovb | **volcanic breccia** | | |
| | | **lamprophyre and related rocks** | | |
| | Omh | **Martinsburg hornfels** | | |
| | Om | **Martinsburg Formation** | | |
| CAMBRIAN | OЄjk | **Kittatinny Supergroup and Jacksonburg Limestone undifferentiated** | | |
| PROTEROZOIC Y | Ygn | **gneiss** | Y | **undifferentiated** (profile only) |
| | Ygr | **granite** | | |
| | Ym | **marble** | | |

FIGURE 2

— 2 — **Residual gravity contour** - interval 1 mGal; dashed where inferred

FIGURE 3

— 57100 — **Aeromagnetic contour** - interval 100 gammas

## MAP SCALE

1:100,000

Base map from U.S. Geological Survey Middletown, NY-NJ-PA 1:100000-scale metric topographic map, 1986. Contour interval 20 meters.

### Table 1. Paleozoic lithostratigraphic units

| System | Lithostratigraphic Unit | Average Thickness (ft) | Description |
|---|---|---|---|
| DEVONIAN | Devonian undifferentiated | 1000 | shale, limestone, sandstone |
| SILURIAN | Silurian undifferentiated | 4500 | sandstone, conglomerate, limestone, shale |
| CAMBRIAN-ORDOVICIAN | Beemerville Intrusive Complex | N/A | calc-alkaline sills, dikes, diatremes |
| | Martinsburg Formation | 7200 | graywacke, sandstone, siltstone, slate |
| | Jacksonburg Limestone and Kittatinny Supergroup undifferentiated | 3700 | dolomite, limestone, sandstone, siltstone |

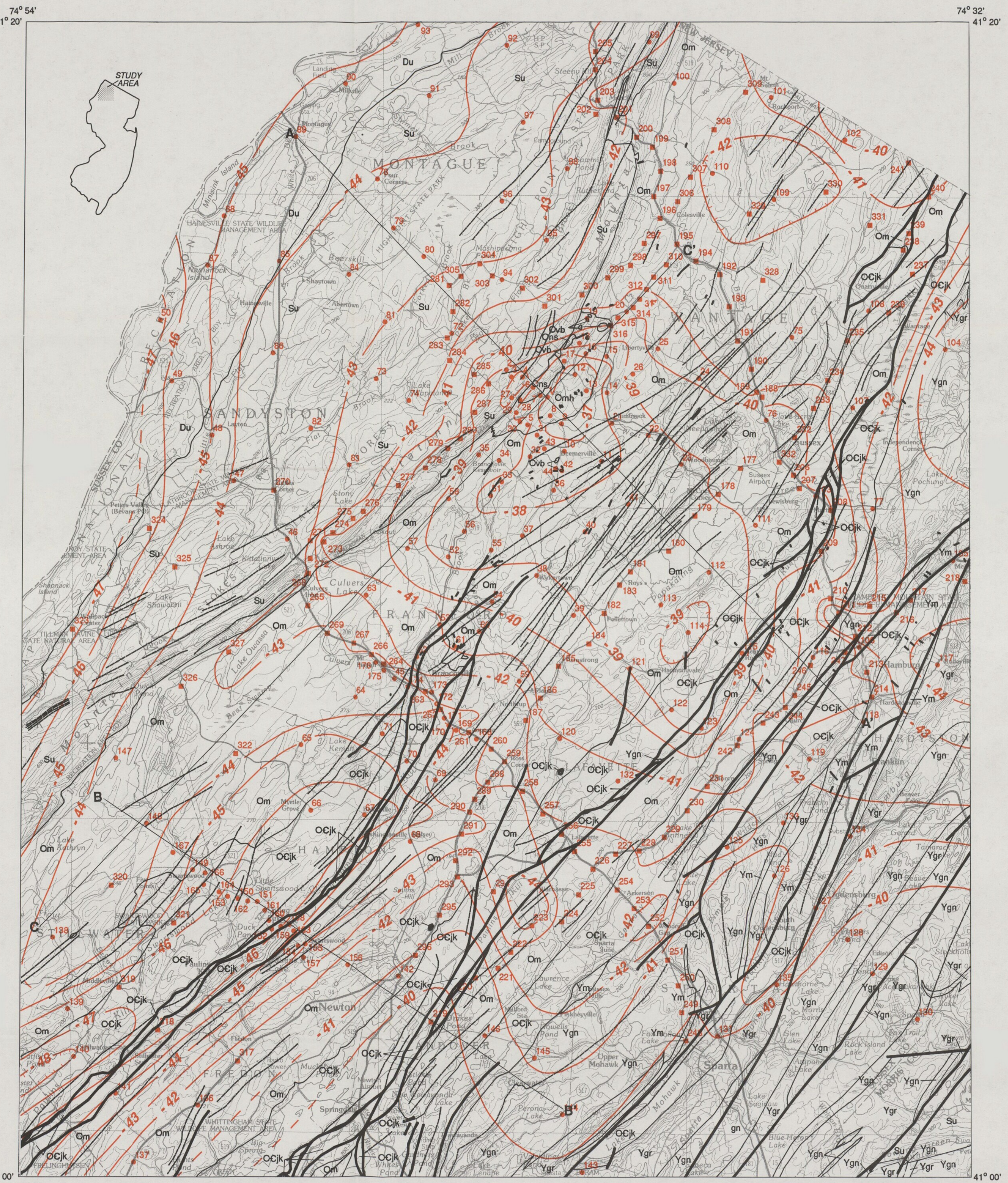

Figure 1. Bouguer gravity anomaly and geologic map.

Bouguer gravity mapped 1985-1988.

Geology compiled by G. Herman, D. Monteverde, and R. Volkert from mapping by D. Monteverde, G. Herman, R. Volkert, A.A. Drake, Jr. (1985-1992). Based in part on Hague and others (1956), Baker and Buddington (1970), and unpublished maps on file at N. J. Geological Survey by W. Spink (1963-1967), F. Markewicz and R. Dalton (1968-1974), R. Canace (1990), and N. J. Zinc Co. (1952). Geologic interpretations are provisional pending peer review.

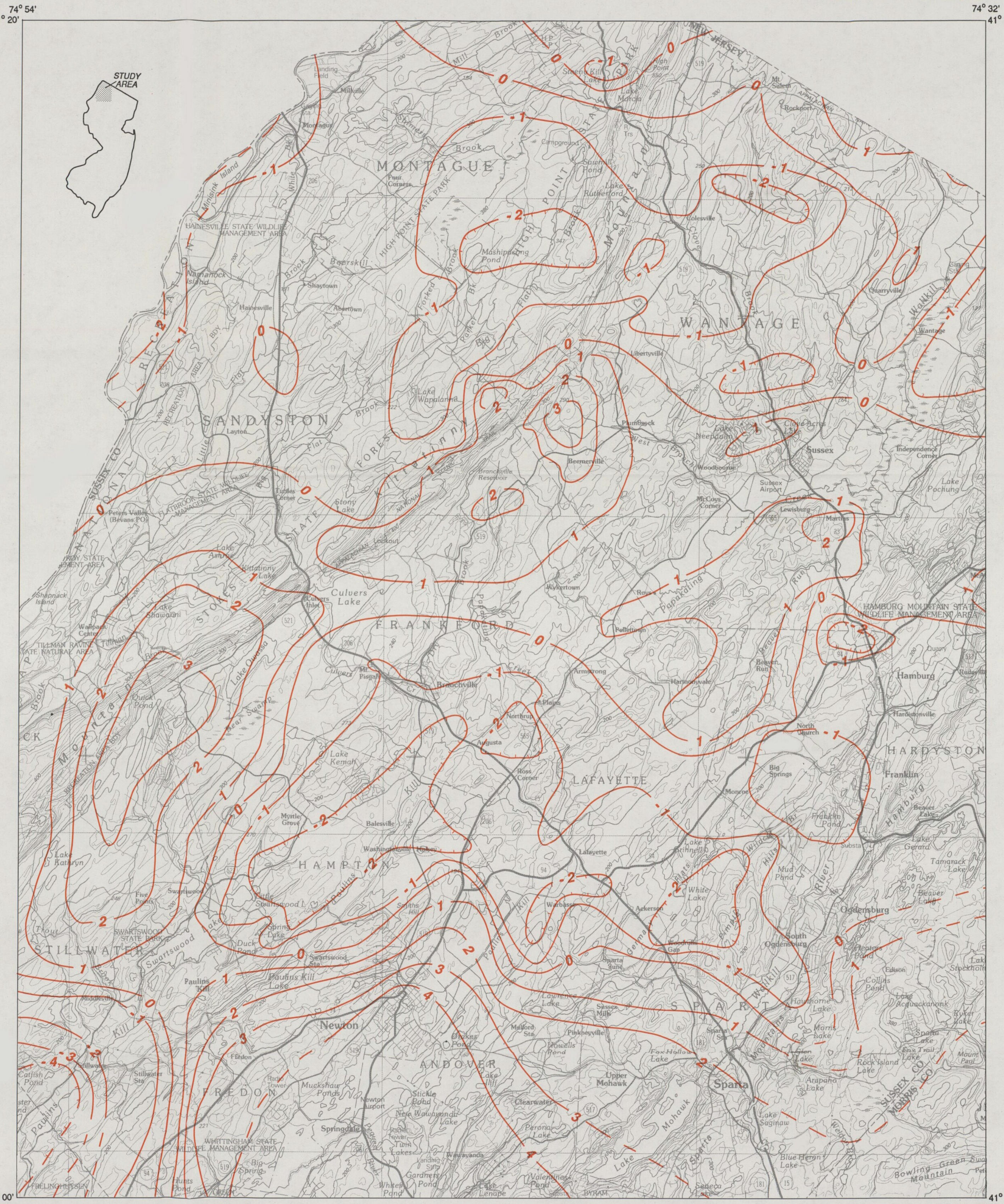

Figure 2. Residual gravity map.

Residual gravity mapped 1985-1988.

# GRAVITY INVESTIGATIONS TO DELINEATE SUBSURFACE GEOLOGY IN THE BEEMERVILLE INTRUSIVE COMPLEX AREA, SUSSEX COUNTY, NEW JERSEY

by

Suhas L. Ghatge, Donald L. Jagel, and Gregory C. Herman

1992

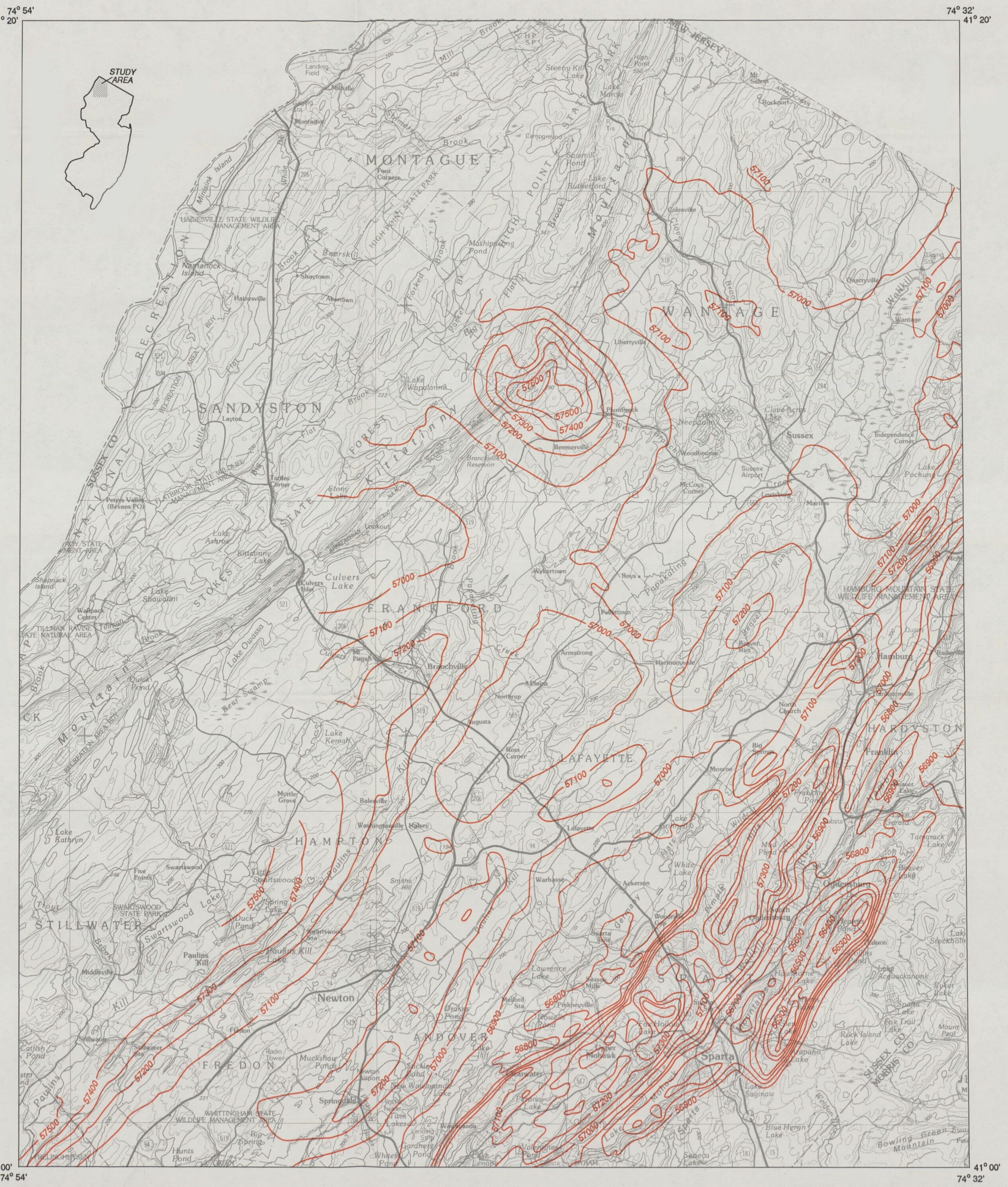

Figure 3. Aeromagnetic map.

Aeromagnetic survey of 1980 by LKB Resources.

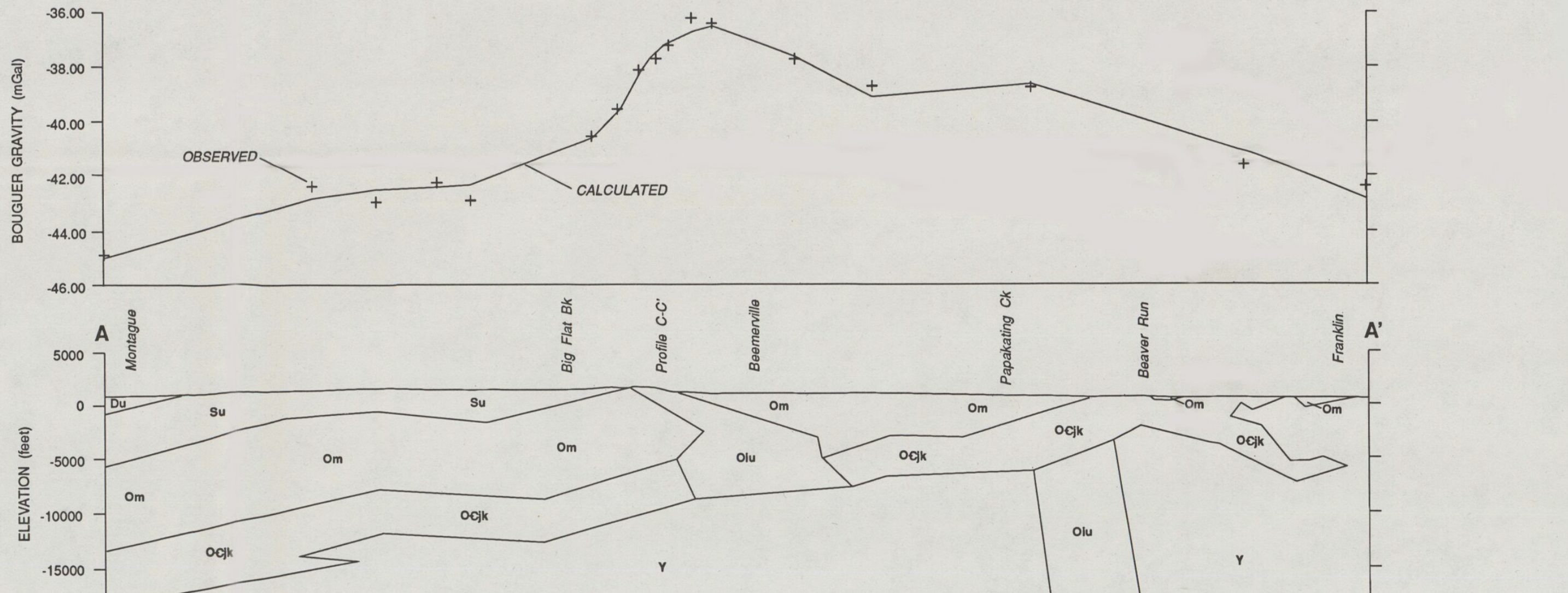

Figure 4. Bouguer gravity anomaly and model of profile A-A'. Line of section shown in Figure 1.

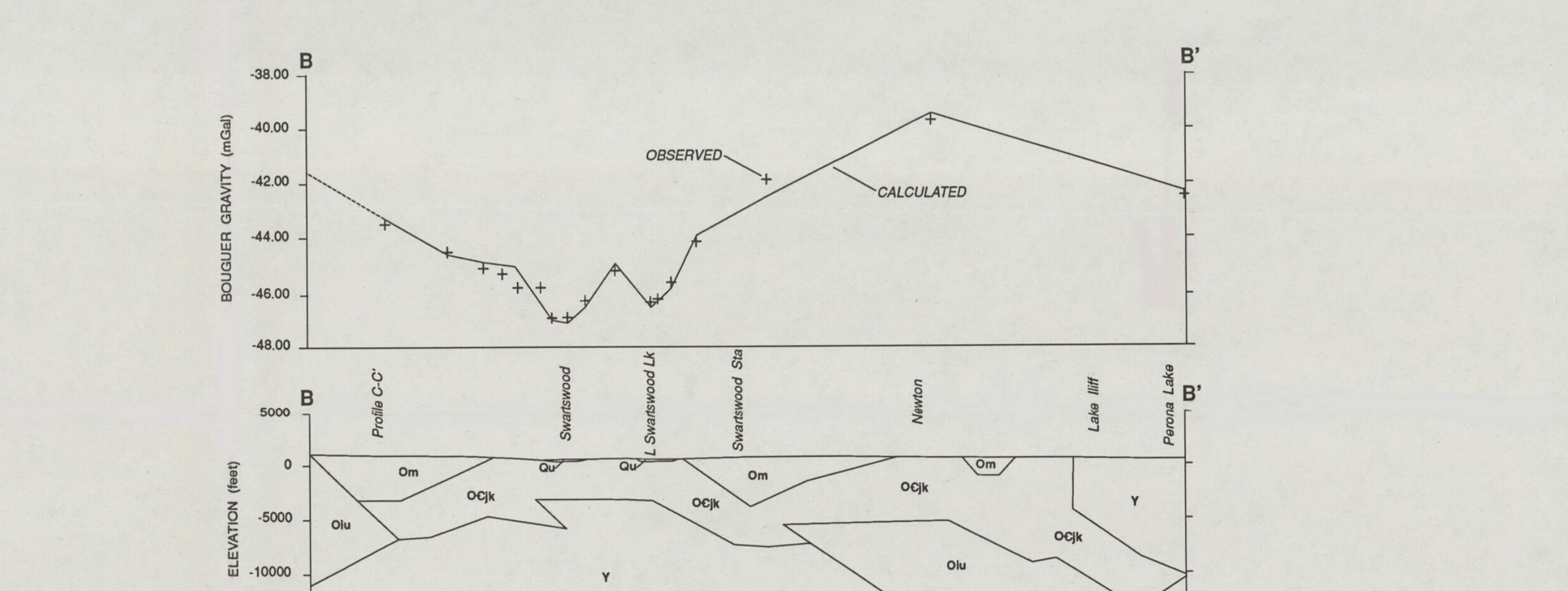

Figure 5. Bouguer gravity anomaly and model of profile B-B'. Line of section shown in Figure 1.

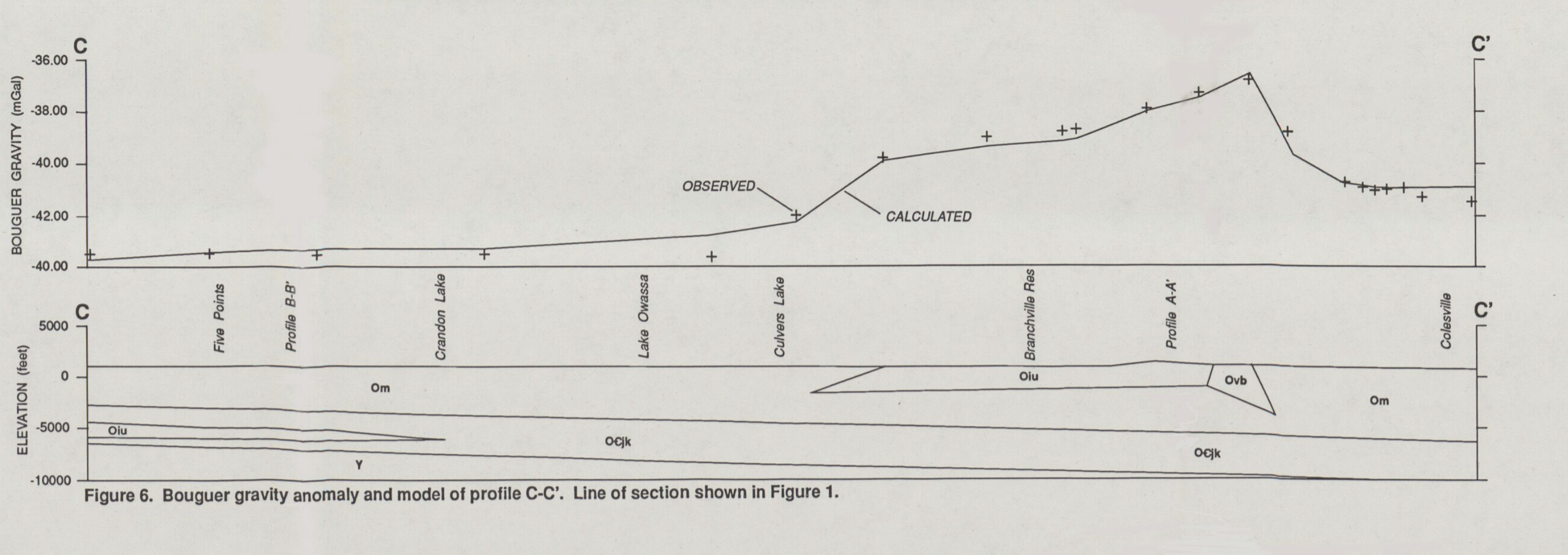

Figure 6. Bouguer gravity anomaly and model of profile C-C'. Line of section shown in Figure 1.