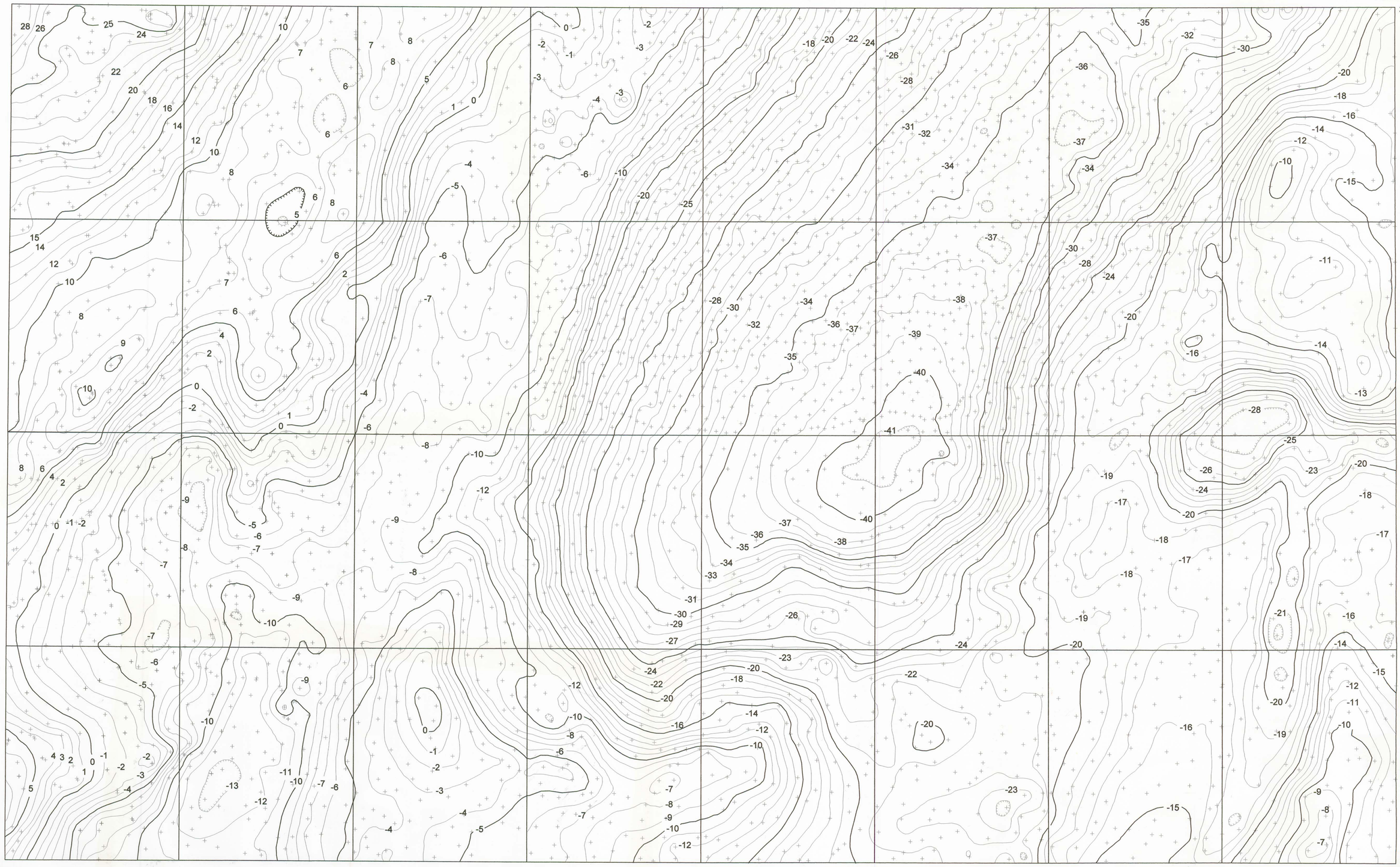
NORTH CAROLINA DEPARTMENT OF ENVIRONMENT, HEALTH AND NATURAL RESOURCES
NORTH CAROLINA GEOLOGICAL SURVEY, DIVISION OF LAND RESOURCES

GEOLOGIC MAP SERIES - 4

79 00' 00" 78 00' 00"

36 00' 00"



35 30' 00"

79 00' 00" 78 00' 00"

Digital Representation by Robert H. Carpenter

SIMPLE BOUGUER GRAVITY ANOMALY MAP, RALEIGH 30 x 60 - MINUTE QUADRANGLE 1996

by

David P. Lawrence

1:100,000 SCALE

0 5 10 Kilometers

0 5 10 Miles

INTRODUCTION

The gravity data for this map are derived from three sources: Stephens (1988) for the northeastern twelve quadrangles, National Geophysical Data Center (NGDC) gravity data base for 6 quadrangles in the western portion of the area, and new data collected by Lawrence in 1994-1996 in 14 quadrangles in the southern part of the area. The map utilizes 1640 data points from Stephens (1988), in the following 7.5-minute quadrangles: Bayleaf, Wake Forest, Rolesville, Bunn West, Bunn East, Spring Hope, Raleigh West, Raleigh East, Knightdale, Zebulon, Middlesex, and Bailey. Lawrence collected 1230 new data points primarily in the following 7.5-minute quadrangles: Lake Wheeler, Garner, Clayton, Flowers, Stancils Chapel, Lucama, Angier, Edmondson, Powhatan, Selma, Kenly West, Kenly East, Fuquay-Varina, and Cokesbury. NGDC data (855 points) and some Lawrence data were used in the following quadrangles: Durham Southwest, Durham Southeast, Green Level, Cary, Apex, and New Hill. Stephens collected his data with a LaCoste-Romberg model G-459 gravity meter. Lawrence used a Texas Instruments Worden gravity meter no. 1297.

BASE STATIONS

Stephens' research utilized no absolute base stations; his maps and data included only relative values. Lawrence re-occupied 10 of Stephens' gravity stations in order to convert his relative values to absolute ones. A conversion value of 979767.26 milligals was added to Stephen's data points.

The new data were tied to the Greenville courthouse gravity base station, given by the U.S. Army as 979776.30 milligals, elevation 64 feet, latitude 35° 36' 48" N, longitude 77° 32' 24" W., five feet south of the east entrance. Numerous occupations of this station were used to establish subsidiary base stations at the localities described below. With the exception of the Black Creek base station, elevations are interpolated from topographic maps.

Black Creek, Wilson 7.5-minute quadrangle (Rocky Mount 30 x 60-minute quadrangle), bench mark at railroad tracks in town: 979753.30 milligals, elevation 126 feet, latitude 35° 38' 14.2" N,longitude 77° 56' 0.8" W.

Rock Ridge, Lucama 7.5-minute quadrangle, intersection of N.C. Route 42 and State Road 1142, concrete base for old gas pumps, next to sign for Gardner's orchard: 979766.96 milligals, elevation 122 feet, latitude 35° 41' 52.1" N, longitude 78° 03' 38" W.

Union Grove, Kenly East 7.5-minute quadrangle, old gas station, under roof, to right of front door, 30 cm from wall: 979762.50 milligals, elevation 140 feet, latitude 35° 32' 39.3" N, longitude 78° 03'1.2" W.

Flowers store, Flowers 7.5-minute quadrangle, to right of western entry door, south-facing gallery, 979743.26 milligals, elevation 292 feet, latitude 35° 39' 14.4" N, longitude 78° 20' 42.8" W.

Shiloh church, Edmondson 7.5-minute quadrangle, front sidewalk, next to black concrete cylinder: 979748.46 milligals, elevation 313 feet, latitude 35° 35' 9.7" N, longitude 78° 33' 11.1" W.

Fuquay-Varina library, Fuquay-Varina 7.5-minute quadrangle, east end of sidewalk next to parking lot: 979750.37 milligals, elevation 378 feet, latitude 35° 34' 58" N, longitude 78° 47' 52" W.

BOUGUER ANOMALY CALCULATION

Gravity tides were corrected by reoccupation of base stations every two hours. In order to calculate the Bouguer anomaly, the theoretical gravity was subtracted from the observed gravity, then the free air correction was added, and the effect of the Bouguer slab (density 2.67 gm/cc) was subtracted.

Theoretical gravity = $978032.67715 \times (1 + 0.0052790414 \times \sin^2 H + 0.0000232718 \times \sin^4 H + 0.0000001262 \times \sin^6 H + 0.0000000007 \times \sin^8 H)$, where H = latitude.

Free air correction = .09406 milligals/foot of elevation.

Bouguer correction = .0341 milligals/foot of elevation.

ESTIMATED DATA ACCURACY

The secondary base stations are estimated to be within 0.05 milligals of their proper values relative to the Greenville Courthouse base station. Individual data points are estimated to be accurate to within 0.05 milligals relative to local base stations. Tidal variations and instrumental drift were corrected by reoccupation of the same base station every two hours. Since variation was assumed to be linear across the time period, some inaccuracies resulted from departure from the real tidal curve, but could only have been about 0.03 milligals at most. Bouguer values were calculated using spot elevations at road intersections, and only rarely at surveyed bench marks. Thus, if local elevations are inaccurate by as much as 2 feet, the combined free air and Bouguer correction would be in error by 0.12 milligals. The calculated Bouguer correction used was 0.0341 milligals per foot, based upon the density value of 2.67 gm/cc. This correction constant is most likely the cause of any errors introduced; it is too high for areas underlain by substantial weathered bedrock or areas with thicker sedimentary sections. For example, if the density of weathered rock or sediment cover was only 2.2 gm/cc, and the thickness 30 feet, the Bouguer correction would allow for a subtraction of 0.18 milligals too much. Thus, all of the estimated inaccuracies in the Bouguer anomaly values sum to about 0.4 milligals. No terrain correction was calculated; this was judged to be an insignificant error because of the relatively low amount of relief in this area.

Stephens estimated that the maximum error in his data set was 0.85 milligals, but most stations were estimated to be within 0.5 milligals. One additional problem may be present in the latitude and longitude data given by Stephens; the overlay grid that he used may have introduced a slight error in many station locations, which do not plot directly at the road intersections where he apparently measured his values.

The data from the National Geophysical Data Center included several data sets of unknown accuracy. Reoccupation of several stations by Lawrence showed that if 0.8 milligals were added to all NGDC data, most stations would be within about 0.5 milligals of values determined in this survey.

Individual quadrangles were contoured using Kriging, and then registered to the 1:100,000-scale base map. The contours were then digitized for production of the final map. Minor inaccuracies may have been introduced in contour placement due to this method of production.

BOUGUER ANOMALIES: DISCUSSION

A large northeast-trending gravity low (-41 mgal minimum) in the central portion of the map is the dominant feature. It is associated with the low density Rolesville granitic batholith, and associated granitic gneisses. The smaller closed low (-28 mgal minimum) in the east-central part of the map is due to the Sims granitoid pluton. Elongate highs and lows in the southeastern part of the map are due to interlayered metasedimentary, and felsic and mafic metavolcanic rocks of the eastern Carolina slate belt. The northeast-trending Nutbush Creek fault zone and northeast-striking schists and gneisses produce the grain of alternating "ridges" and "valleys" in the contours in the north-central part of the area. The high values (up to 28 mgal) along the western margin lie within the Carolina slate belt, and are probably caused by dense volcanic rocks and mafic plutons. An amphibolite unit produces the arcuate gravity high in the south-central portion of the map (0.0 mgal maximum).

ACKNOWLEDGEMENTS

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REFERENCES

Stephens, Edward Harrison, 1988, Structure of the Rolesville batholith and adjacent metamorphic terranes in the east-central Piedmont of North Carolina: a geophysical perspective: MS thesis, Raleigh, North Carolina, North Carolina State University, 166 p.

LEGEND

+ Data point collection site

-20 Gravity anomaly isogal, 1milligal isogal interval, hatchured contour indicates depression