Base from U. S. Geological Suvery, Charlotte, 1953-1974
Transverse Mercator Projection.

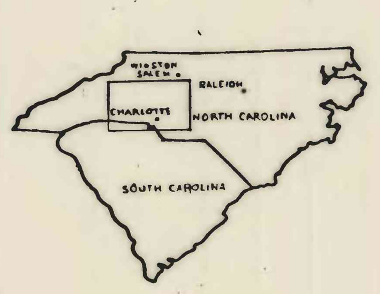
SCALE 1:250 000

EXPLANATION

Simple Bouguer Gravity Contours

Contour interval 2 milligals. Dashed in areas of sparse data. Hachured contours indicate areas of lower gravity.

Gravity Station



LOCATION DIAGRAM

Table 1.--Source of Gravity data

1. F.A. Wilson - 1286 stations, new data
2. Watkins and Yuval (1966)1/ - 860 stations
3. Snyder (1963)1/ - 254 stations
4. Morgan and Mann (1964)1/ - 215 stations
5. Best, Geddes and Watkins (1971)1/ - 139 stations
6. Mann, V.I., and others (1957-1961)2/ Gravity measurements in North Carolina, Trip AM, Series L, Chapel Hill, N.C., University of North Carolina. - 91 stations
7. Zablocki (1959)2/ A gravity study in the Deep River-Wadesboro Triassic basin of North Carolina: Chapel Hill, N.C., University of North Carolina, M.S. thesis - 72 stations
8. Ressetar and Bridges (1974) University of South Carolina and Georgia Institute of Technology Gravity Field Notes; Long and others (1975) - 37 stations
9. U.S. Coast and Geodetic Survey (undated)2/ National Gravimeter base network - 17 stations
10. TOPOCOM (1968)2/ Gravity data in South Carolina: U.S. Army Topographic Command - 16 stations
11. Woollard and others (1947)2/ Gravity measurements: Trip VS Series E, Princeton University - 10 stations

1/ Original data not available; contours interpolated.
2/ Unpublished data from the Defense Mapping Agency, DOD Gravity Services Branch, St. Louis, Mo. 63118.

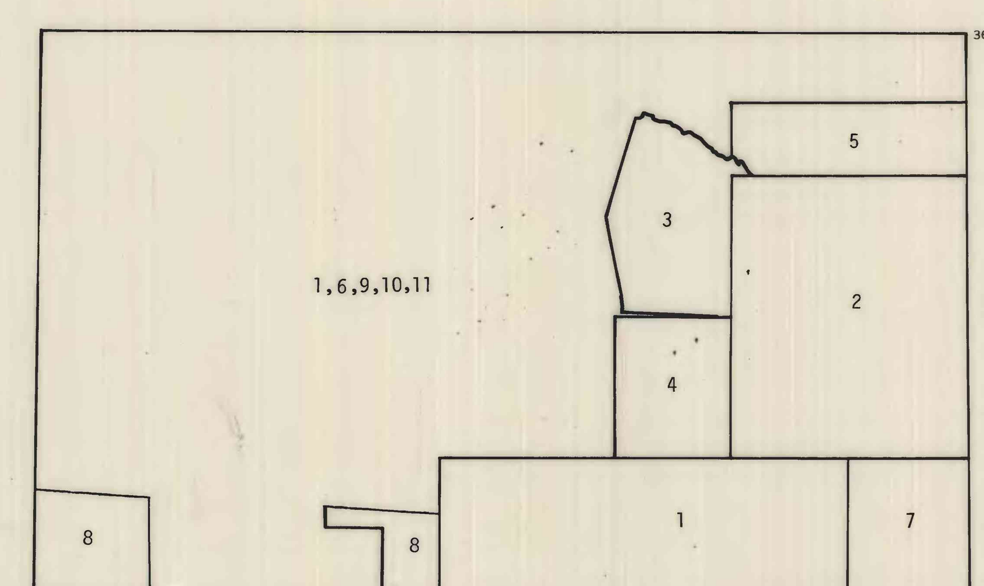


Figure 1.--Gravity data sources for the Charlotte 2° sheet.

Figure 2.--Generalized geology and Piedmont belt boundaries modified from Goldsmith and others, 1978 for the Charlotte 2° sheet showing simple Bouguer contours.

The gravity map of the Charlotte 1 x 2 degree quadrangle (plate 1) was compiled from 2997 gravity measurements, of which 1286 were made by the senior author in 1977, and the remainder were obtained from previous published reports (see figure 1, table 1). Surveyed road intersections obtained from U.S. Geological Survey 7.5-minute topographic maps provided the bulk of the reference elevations for the new measurements. These elevations have a claimed accuracy of ± 0.3 m (± 1 foot) and result in a possible Bouguer gravity error of ± 0.06 milligals due to elevation uncertainty. The accuracy of the data from the other sources is unknown. Reading accuracy of the gravity meter is 0.01 milligals. Each day's measurements were tied to a series of local base stations which, in turn, were tied to National Gravity Network Station "Charlotte A" (Dept. of Defense Ref. no. 2096-1, Defense Mapping Agency, 1970) at the University of North Carolina at Charlotte with a value of 979,728.06 mgls, adjusted to conform to the 1971 International Gravimetric Net (Morelli, 1974).

The field measurements were reduced by computer using a program that corrects for earth tides and instrument drift. Latitude corrections are based on the 1967 International Gravity Formula (Internat. Assoc. of Geodesy, 1971). A Bouguer density of 2.67 gm/cc was used on all stations, and no terrain corrections were made because the topographic effect is negligible for most of the map area. However, in the mountainous northwest corner of the map (lat 35° 45' to 36° 00' N; long 81° 45' to 82° 00'W), where elevation control is poor, terrain corrections for stations may be as high as 1.98 milligals.

Regional Gravity

The major feature of the gravity field in the Charlotte 1 x 2 degree quadrangle is a segment of a northeast-trending gravity gradient that extends the full length of the Appalachian orogen from Newfoundland to Alabama (Woollard and Joesting, 1964; Haworth, 1978). The gravity gradient lies between a deep low on the NW and a plateau of higher values to the southeast and probably separates crustal terranes of markedly different compositions. Within the quadrangles, superimposed on the gradient, are major anomalies caused by shallower exposed rocks of the Piedmont.

Correlation of Geology and Gravity

Most of the Charlotte 1 x 2 degree quadrangle is located within the Piedmont province and contains four of the major Piedmont litho-tectonic belts (see fig. 2). Small parts of the Brevard fault zone and the Blue Ridge are located in the northwest norner of the quadrangle, and part of the Triassic-Jurassic Durham-Wadesboro Basin is located in the southeast corner.

Within the quadrangle, Bouguer gravity anomalies correlate well with exposed major rock units and reflect the lithology and structural styles of the Piedmont belts (see fig. 3). Positive gravity anomalies generally coincide with mafic rocks and negative anomalies generally coincide with felsic rocks. Other geophysical data support these anomaly-rock relationships. Aeromagnetic highs generally coincide with mafic igneous rocks (U.S. Geological Survey, 1977a, 1977c, 1977f, 1978c) and aeroradioactivity highs generally occur over potassium-rich felsic rocks (U.S. Geological Survey, 1977b, 1977d, 1977e, 1978a, 1978b).

<u>Slate belt</u>. The Slate belt is characterized by an undulating anomaly pattern that reflects the open folds in the metasedimentary and metavolcanic rocks in the southeastern part of the map. The broad 30 mgl high, which peaks at S (fig. 2) in eastern Davidson County (Watkins and Yuval, 1966), is part of a band of positive gravity anomalies as large as 50 mgls that lies east of the gravity gradient and extends from Alabama to Connecticut. In Montgomery County, the broad elliptical low at W (fig. 2) outlines felsic volcanics of the Uwharrie formation and emphasizes the structure of the Troy anticline (Conley and Bain, 1965). Part of the Slate belt-Charlotte belt boundary coincide with the Gold Hill-Silver Hill faults system. This fault is expressed on the map by a series of small low-amplitude anomalies with flat eastern sides in eastern Cabarrus and Rowan Counties.

<u>Charlotte belt</u>. The Charlotte belt has a knobby anomally pattern caused by numerous large granitic and gabbroic stocks. Major plutons in the belt have been listed by Butler and Ragland (1969).

Metamorphosed granitic plutons of the Salisbury group 413-386 m.y.-old (Butler and Fullagar, 1978) are concentrated along the eastern part of the belt. These plutons Southmount-A, Salisbury-B, and Gold Hill-C are characterized by low-amplitude gravity lows, aeromagnetic lows, and aeroradioactivity highs (U.S. Geological Survey, 1977a, 1977b). The low amplitudes of these 4-6 mgl gravity anomalies and the magnitude of density contrast between mafic volcanics and adamellite suggest plutons of limited thickness. Anomaly D, directly south of the Salisbury pluton (Morgan and Mann, 1964), is caused by a similar adamellite body (Goldsmith and others, 1978).

A western group of 325-265 m.y.-old, post-metamorphic granitic plutons (Fullagar and Butler, 1979) forms a line of large high-amplitude gravity lows (Churchland-G, Landis-H, Clover-K, York-L) in the central and western parts of the belt. These plutons also have associated aeromagnetic lows and very high aeroradioactivity anomalies. Two significant gravity lows along this line at Berryhill (J) and Huntersville (I) have associated aeroradioactivity lows, but the gravity low at Huntersville (I) is not correlated with exposed granitic rock. The geophysical features found at Huntersville are similar to those of potassium-poor, felsic plutons at F (Morgan and Mann, 1964, p. 150) and at Stallings (E) (Goldsmith and others, 1978); and the presence of a similar subsurface pluton southwest of Huntersville is probable.

Major positive gravity anomalies in the belt are associated with large gabbro-metagabbro complexes. Most of these have been discussed; the Barber and the Bear Poplar (N) by Snyder (1963); the Concord (O) by Morgan and Mann (1964); and the Mecklenburg (P) by Hermes (1968). The linear gravity feature that runs from the Bear Poplar and the Barber gabbro (N) to the Farmington gabbro (M) suggests these two bodies may be connected at depth. The large gravity high at Cornelius (R) suggests the presence of a larger subsurface mass of gabbro than is indicated by the small surface area of gabbro outcrop (Goldsmith and others, 1978). The Weddington gabbro is responsible for the positive anomaly at Q, and may be a part of the Mecklenburg gabbro complex.

<u>Kings Mountain belt</u>. The Kings Mountain belt - Charlotte belt boundary coincides with a gravity gradient that passes through northern Mecklenburg and eastern Gaston Counties, N.C. The gradient is deflected from the mapped belt boundary (Goldsmith and others, 1978) by the Clover (K) and York (L) granitic plutons (Horton and Butler, 1977, p. 90) in York County. The lowest anomaly in the Kings Mountain belt correlates with the Toluca granitic pluton (T) (Horton and Butler, 1977, p. 90). The narrow elongate anomalies of this Belt trend northeastward and merge with Charlotte-belt anomalies in southern Iredell County. Present gravity data gives no evidence for further northward extension of the belt (Horton and Butler, 1977, p. 83).

<u>Inner Piedmont</u>. The Inner Piedmont - Kings Mountain belt boundary (Goldsmith and others, 1978) is a major shear zone in Cherokee County, and Cleveland County (Horton and Butler, 1979, Caledonides Abst.). This shear zone closely follows the northeast-trending gravity gradient in western Gaston and central Lincoln Counties. The gradient widens where exposures of Cherryville quartz monzonite (X) are found east of the shear zone in western Gaston County. Present gravity data and the northeast-trending linear gradient indicate that the fault may extend into Lincoln County. The pattern of paired, rather broad, low-amplitude high and low gravity anomalies in southwestern Lincoln and southeastern Cleveland Counties correlates with the Cherryville quartz monzonite (X) (Horton and Butler, 1977) and Toluca quartz monzonite (Y) (Overstreet and others, 1963).

A strong regional gravity gradient covers most of the Inner Piedmont and terminates in negative anomalies of -102 and -104 mgals over the Blue Ridge in northwestern Burke and Caldwell Counties. Disturbances in the relatively smooth regional gravity gradient in the Inner Piedmont, especially in the area west of the Toluca quartz monzonite, may indicate other intrusive bodies, but more data are needed to properly define these features.

References Cited

Best, D. M., Geddes, W. H., and Watkins, J. S., 1971, Simple Bouguer gravity map of the Churchland, Lexington West, Lexington East, and Fiar Grove quadrangles, central North Carolina: unpublished map, scale 1:62,500, contour interval 1 milligal. (Written communication from D. M. Best, Flagstaff, Arizona, Northern Arizona University.)

Butler, J. R., 1977, The Gold Hill fault zone in the Carolinas: age of movement and southwestern extention, Geological Society of America abstracts with programs, v. 9, no. 2, p. 125.

Butler, J. R., and Fullagar, P. D., 1978, Petrochemical and geochemical studies of plutonic rocks in the southern Appalachians: III. Leucocratic adamellites of the Charlotte belt near Salisbury, North Carolina: Geological Society of America Bulletin, v. 89, p. 460-466.

Butler, J. R., and Ragland, P. C., 1969, A petrochemical Survey of Plutonic intrusions in the Piedmont, Southeastern Appalachians, U.S.A.: Contributions to Mineralogy and Petrology, v. 24, p. 164-190.

Conley, J. F., and Bain, G. L., 1965, Geology of the Carolina Slate belt west of the Deep River-Wadesboro Triassic basin, North Carolina: Southeastern Geology, v. 6, no. 3, p. 117-138.

Defense Mapping Agency, 1970, World relative gravity network, North America volume: St. Louis, Mo., Aeronautical Chart and Information Center, U.S. Department of Defense Gravity Services Branch, ACIC RP 25, ref. no. 2096-1.

Fullagar, P. D., and Butler, R. J., 1979, 325 to 265 m.y.-old granitic plutons in the Piedmont of the southeastern Appalachians: American Journal of Science, vol. 279, no. 2, p. 161-285.

Goldsmith, Richard, Milton, D. F., and Wilson, F. A., 1978, Preliminary geologic map, geologic map index, and annotated bibliography, Charlotte 2° sheet, North Carolina and South Carolina: U.S. Geological Survey Open-File Report 78-590, 19 p., 3 pl., scale 1:250,000.

Haworth, R. T., 1978, Interpretation of geophysical data in the northern Gulf of St. Lawrence and its relevance to lower Paleozoic geology: Geological Society of America Bull., v. 89, p. 1091-1110.

Hermes, O. D., 1968, Petrology of the Mecklenburg gabbro-metagabbro complex, North Carolina: Contributions to Mineralogy and Petrology, v. 18, p. 270-294.

Horton, J. W., and Butler, J. R., 1977, Guide to the geology of the Kings Mountain belt in the Kings Mountain area, North Carolina: in Burt, E. R., ed., Field guides for Geological Society of America, Southeastern Section Meeting, Winston-Salem, North Carolina, N.C. Dept. of Natural and Economic Resources, p. 76-143.

Horton, J. W., and Butler, J. R., 1979, Structural relationships of the Kings Mountain belt in the Piedmont of the Carolinas: Abstracts, The Caledonides in the USA, I.G.C.P., Blacksburg, Virginia, p. A17.

International Association of Geodesy, 1971, Geodetic Reference System, 1967: International Association of Geodesy, Special Publication 3, 116 p.

Long, L. T., Talwani, P., and Bridges, S. R., 1975, Simple Bouguer gravity map of South Carolina: South Carolina Development Board, Div. Geol., Scale 1:500,000.

Morelli, Carlo (ed.), 1974, The International Gravity Standardization Net 1971 (I.G.S.N. 71): International Association of Geodesy Special Publication 4, p. 194.

Morgan, B. A., and Mann, V. I., 1964, Gravity Studies in the Concord quadrangle, North Carolina: Southeastern Geology, v. 5, p. 143-156.

Overstreet, W. D., Yates, R. G., and Griffitts, W. R., 1963, Geology of the Shelby quadrangle, North Carolina: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-384.

Ressetar, Robert, and Bridges, S. R., 1974, Gravity field survey notes 1974: Univ. of South Carolina Survey Notes No. 11 and 18. (Written communication from L. T. Long, Atlanta, Ga., Georgia Institute of Technology.)

Snyder, J. F., 1963, A gravity study of Rowan County, North Carolina: Chapel Hill, N.C., Univ. of North Carolina, M.S. thesis.

U.S. Geological Survey, 1977a, Aeromagnetic Map of north-central North Carolina: U.S. Geological Survey Open-file Map 77-192, scale 1:25,000.

_____, 1977b, Aeroradioactivity Map of north-central North Carolina: U.S. Geological Survey Open-file Map 77-193, scale 1:250,000.

_____, 1977c, Aeromagnetic map of Spartanburg and vicinity, South Carolina: U.S. Geological Survey Open-file Map 77-252, scale 1:250,000.

_____, 1977d, Aeroradioactivity map of Spartanburg and vicinity, South Carolina: U.S. Geological Sdrvey Open-file Map 77-253, scale 1:250,000.

_____, 1977e, Aeroradioactivity map of Charlotte and vicinity, North Carolina: U.S. Geological Survey Open-file Map 77-722, scale 1:250,000.

_____, 1977f, Aeromagnetic map of Charlotte and vicinity, North Carolina: U.S. Geological Survey Open-file Map 77-723, scale 1:250,000.

_____, 1978a, Aeroradioactivity map of Salisbury and vicinity, North Carolina: U.S. Geological Survey Open-file Map 78-262, scale 1:125,000.

_____, 1978b, Aeroradioactivity map of West Charlotte, North Carolina: U.S. Geological Survey Open-file Map 78-1087, scale 1:250,000.

_____, 1978c, Aeromagnetic map of West Charlotte, North Carolina; U.S. Geological Survey Open-file Map 78-1088, scale 1:250,000.

Watkins, J. S., and Yuval, Zvi, 1966, Simple Bouguer gravity map of the Mount Pleasant, Albemarle, Denton, and Salisbury quadrangles, west-central North Carolina: U.S. Geological Survey Geophysical Investigations Map GP-582, scale 1:62,500.

Wollard, G. P., and Joesting, H. R., 1964, The Bouguer gravity anomaly map of the United States: American Geophysical Union, U.S. Geological Survey, Washington, D.C.

PRELIMINARY SIMPLE BOUGUER GRAVITY MAP OF THE CHARLOTTE 1 X 2° QUADRANGLE, NORTH CAROLINA AND SOUTH CAROLINA

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1980