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GRAVITY SURVEY OF NORTHAMPTON AND ACCOMACK COUNTIES, VIRGINIA

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INTRODUCTION

This report and accompanying map (Figure 1, p. 24, 25) of the Eastern Shore Peninsula are portions of a continuing geophysical program by the Virginia Division of Mineral Resources to obtain State-wide gravity and magnetic coverage. This information, when used with other geophysical and geological data, will aid in interpretation of the subsurface geology. The field observations were made by the authors in May 1970, utilizing two LaCoste and Romberg Model C geodetic meters (numbers 77 and 46) that have a range of over 7000 milligals and a reading accuracy of ± 0.01 milligal. Field procedures utilized the loop technique in a modified ladder sequence for obtaining the gravity values. Each loop was started and closed the same day from an established base station.

A total of 254 stations were occupied in Virginia, and an additional 9 stations were occupied in Maryland to give the necessary peripheral control. Gravity observations were made only at U. S. Geological Survey and U. S. Coast and Geodetic Survey bench marks that had been established by means of first through third order leveling. At each gravity station, three consecutive readings that had a maximum spread no greater than 0.01 milligal were obtained within 3 minutes. A previously occupied station in a loop was reoccupied every 2 to 3 hours during the survey, and an average of 17 percent of the individual stations were reobserved within each loop. Stations were plotted on standard 7.5-minute quadrangle topographic maps. Established horizontal control was utilized for station coordinates where available, and the latitude and longitude of all other stations were scaled from the topographic maps.

Bases were established at Eastville, on U. S. Geological Survey bench mark R 45 1929 (mark not stamped), in the county courthouse yard; at Melfa, on U. S. Geological Survey bench mark R 38 1929 Reset 1962, in the old Post Office yard; and at Wallops Station on U. S. Coast and Geodetic Survey bench mark M 421 1963. After these stations had been occupied and results computed and reviewed, the Eastville base was assigned a value of 979,921.080 milligals, the Melfa base a value of 979,958.672 milligals, and the Wallops Station base a value of 979,972.328 milligals. The Eastville base was established from the Norfolk base, and the Melfa and Wallops Station bases were established from the Eastville base. All of the base-loop observations were occupied in a ladder sequence.

To ascertain the relation of the gravity data collected in Northampton and Accomack counties to the Division's master base in Charlottesville, a sequence of two base-loop occupations was made with gravity meter number 77 from Charlottesville to the Norfolk Municipal Airport before the survey of the Eastern Shore was started. These two individual loops included stations at Richmond, Williamsburg, and Norfolk, which are adjusted to the National Gravity Base Net. These stations, as well as several bases in Northampton and Accomack counties, were previously established in the National Base Net System by the U. S. Army Topographic Command. The field data from the two loops were computed holding the value for Charlottesville constant. The Charlottesville base, U. S. Geological Survey bench mark 106 MLS 1963, is in the Virginia Gravity Base Net that is tied to the National Gravity Base Net. The Charlottesville base station has an established value of 979,933.558 milligals; this value is relative to the National gravity datum at station Washington A which has a value of 980,118.000 milligals.

DATA REDUCTION

The computation and reduction of field data were done on a Burroughs 5500 computer at the Computer Science Center, University of Virginia, Charlottesville, utilizing a modified GRAVAS program. This program is designed to reduce field observations obtained by LaCoste and Romberg gravity meters and corrects the field observations for solar and lunar tides and instrument drift. A density of 2.67 g/cm ^{3} was used for computing the Bouguer values. The Division receives a computer print-out that lists the station name, coordinates, elevation, observed gravity, and the free-air, Bouguer, and theoretical gravity values. In addition to the print-out, all the information for each station except the theoretical value is punched on an output card. A set of the gravity-data cards for all stations in the Eastern Shore project with all of the principal facts except the theoretical value may be obtained from the Division of Mineral Resources for $25.00. The card format is shown in Figure 2.

OBSERVATIONS AND DISCUSSION

The gravity patterns depicted by the contours on Figure 1 correspond in general to magnetic maps of the Eastern Shore and vicinity (Balsley and others, 1946; Le Van and Pharr, 1963; U. S. Naval Oceanographic Office, 1967). The closed low in the vicinity of Cheriton contains the low-

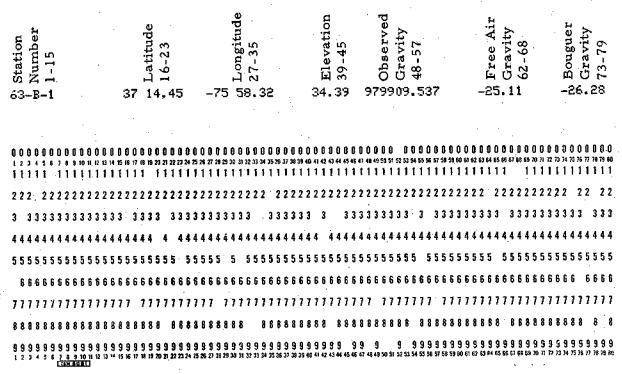


Figure 2. Format of output data card utilized for gravity survey program.

est gravity value observed during this survey. This value of -27.0 milligals just south of Cheriton is 19.8 milligals lower than the highest gravity value of -7.2 milligals, which is located in the closed high between Exmore and Melfa. The magnetic map published by the U. S. Naval Oceanographic Office (1967) shows a closed magnetic low in the Chesapeake Bay area west of Cheriton

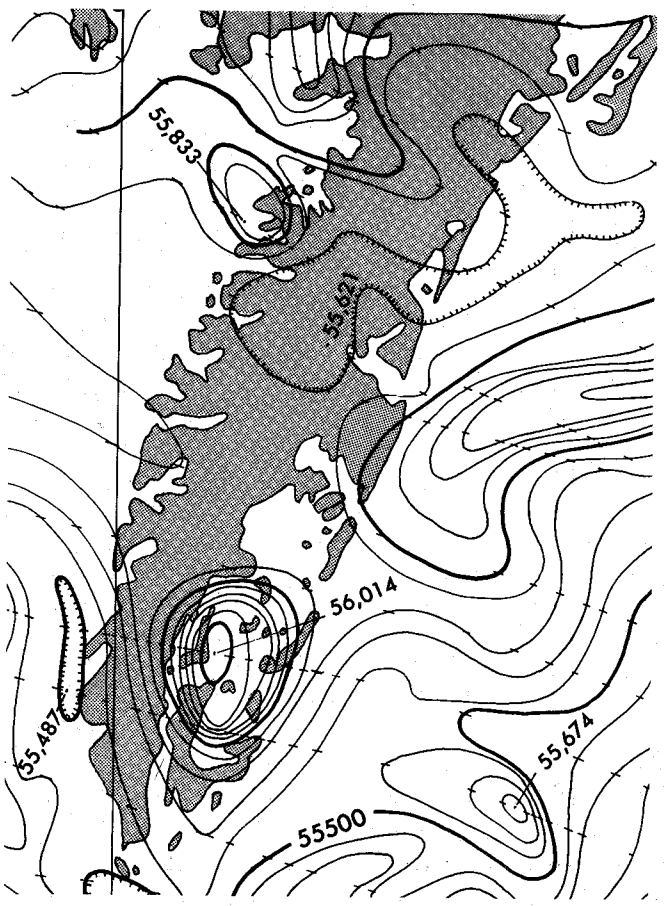


Figure 3. Portion of total intensity magnetic map showing Eastern Shore area (from U. S. Naval Oceanographic Office, 1967).

(Figure 3) which may be associated with the gravity low. The magnetic maps do not indicate a magnetic feature that could be associated with the Exmore-Melfa gravity high. This may be due to the absence of a flight line through the anomalous gravity area (Le Van and Pharr, 1963, p. 13; U. S. Naval Oceanographic Office, 1967). The Bouguer Gravity Anomaly Map of the United States (American Geophysical Union and U. S. Geological Survey, 1964) shows a -10 milligal

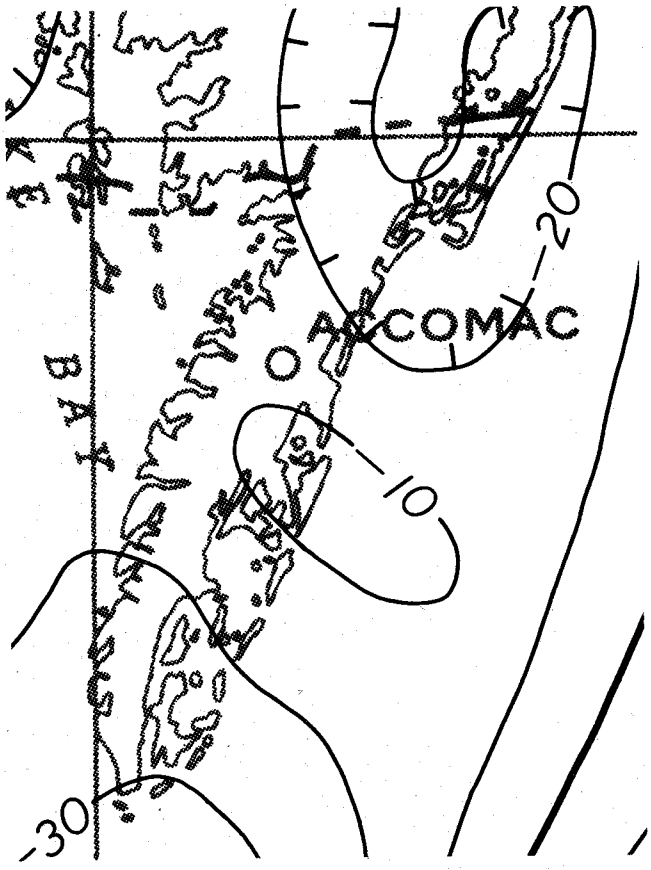


Figure 4. Portion of Bouguer gravity anomaly map showing Eastern Shore area (from American Geophysical Union and U. S. Geological Survey, 1964).

closure in the south-eastern part of Accomack County and extending into the Atlantic Ocean (Figure 4). This closure is probably the same feature, with an offshore extension, as the Exmore-Melfa gravity high mapped during the present investigation. Low gravity values were recorded on Wallops Island where the maximum low value was -25.4 milligals. These lower gravity values seem to correspond to a magnetic low in the vicinity of Wallops Island (Figure 3). The gravity values are higher northward from Wallops Station, and the northernmost station occupied, approximately 1.7 miles north of the Maryland-Virginia boundary, had a value of -18.9 milligals. These increasing gravity values seem to correspond to the gradient at the south end of the northwestward-trending magnetic high shown by Balsley and others (1946) in the Stockton-Girdletree area of Maryland.

A map showing the configuration of the basement surface in the Eastern Shore area (DeBuchananne, 1968) indicates that about 4000 to 4500 feet of sediments overlie the basement in the vicinity of the Exmore-Melfa gravity high. Contours on the basement in the Wallops Island area indicate approximately 7500 to 8000 feet of sediments near the gravity low. The difference in the gravity field between the Wallops Island low and the Exmore-Melfa high (maximum of 18.2 milligals) is about equivalent to the calculated gravity change for the estimated change in thickness of the Coastal Plain sediments (4000 feet, density contrast of 0.3 g/cm^3; Coastal Plain sediments about 2.4 g/cm^3, basement about 2.7 g/cm^3). Available geophysical data indicate that this gradual increase in the gravity field from Wallops Island to the Exmore-Melfa area may be a reflection of basement relief. South of the Exmore-Melfa gravity high, the irregularity of the gravity field may be caused by basement relief, intrasediment changes, intrabasement lithologic variations, or some combination of these.

The relationship of the gravity and magnetic data in the Cheriton area reflect changes in basement lithology. The higher gravity values north of Wallops Island and the associated magnetic anomaly (Balsley and others, 1946) are interpreted as a lithologic change in the basement. This magnetic anomaly in the Stockton-Girdletree area may indicate a rise in the basement or an underlying, anomalous block probably less than a mile in vertical extent (Steenland, 1951, p. 23).

The basement rock has not been reached in wells drilled in Northampton or Accomack counties, but was reached in wells drilled near Salisbury and Berlin, Maryland, a distance of approximately 27 miles north of the survey area. A well drilled by the Ohio Oil Company near Salisbury penetrated the basement at 5529 feet (Balsley and others, 1946). The Socony-Vacuum well, near Berlin, encountered basement rock at 7157 feet (Richards, 1967, p. 2415). A well north

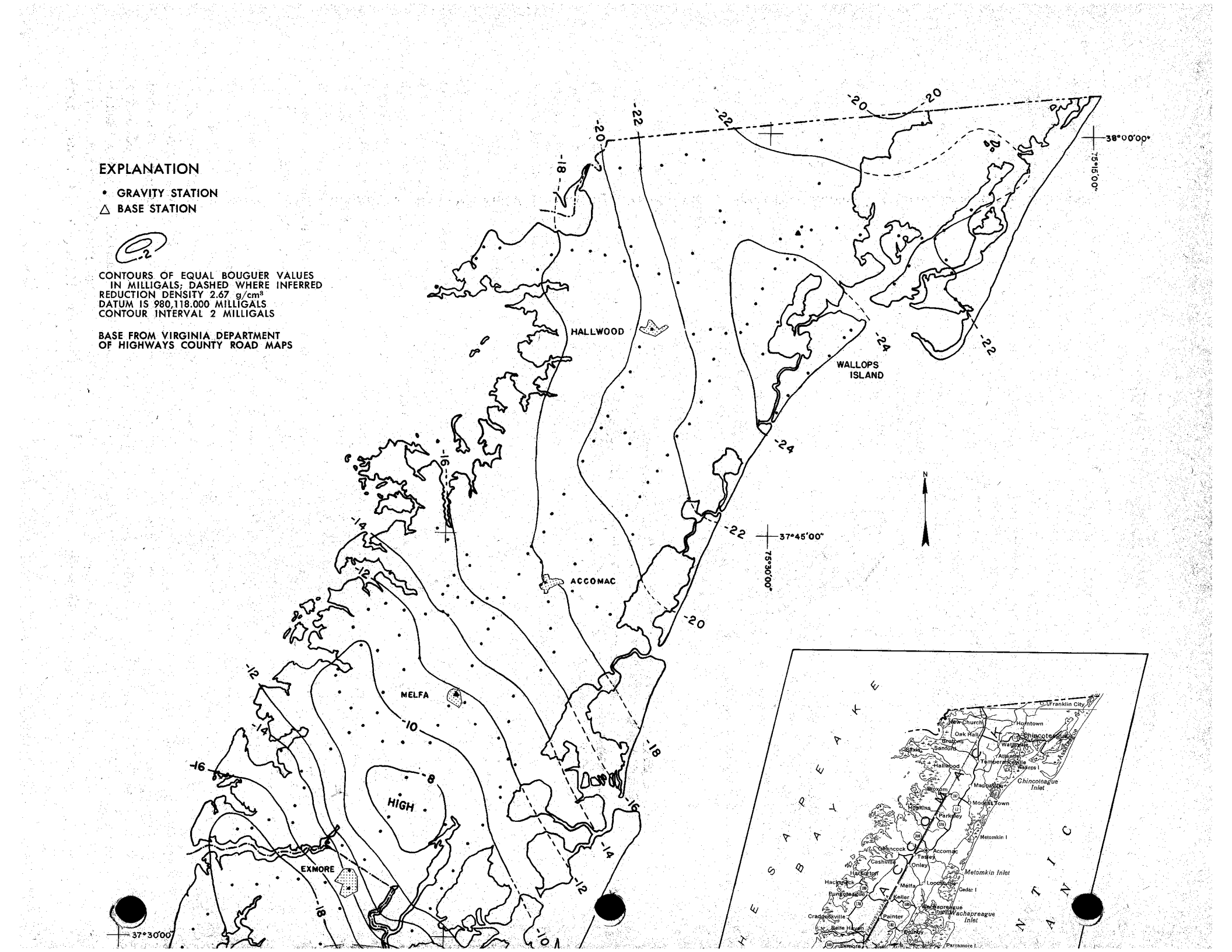
EXPLANATION

- • GRAVITY STATION
- △ BASE STATION

-2 CONTOURS OF EQUAL BOUGUER VALUES IN MILLIGALS; DASHED WHERE INFERRED

REDUCTION DENSITY 2.67 g/cm³
DATUM IS 980,118.000 MILLIGALS
CONTOUR INTERVAL 2 MILLIGALS

BASE FROM VIRGINIA DEPARTMENT OF HIGHWAYS COUNTY ROAD MAPS



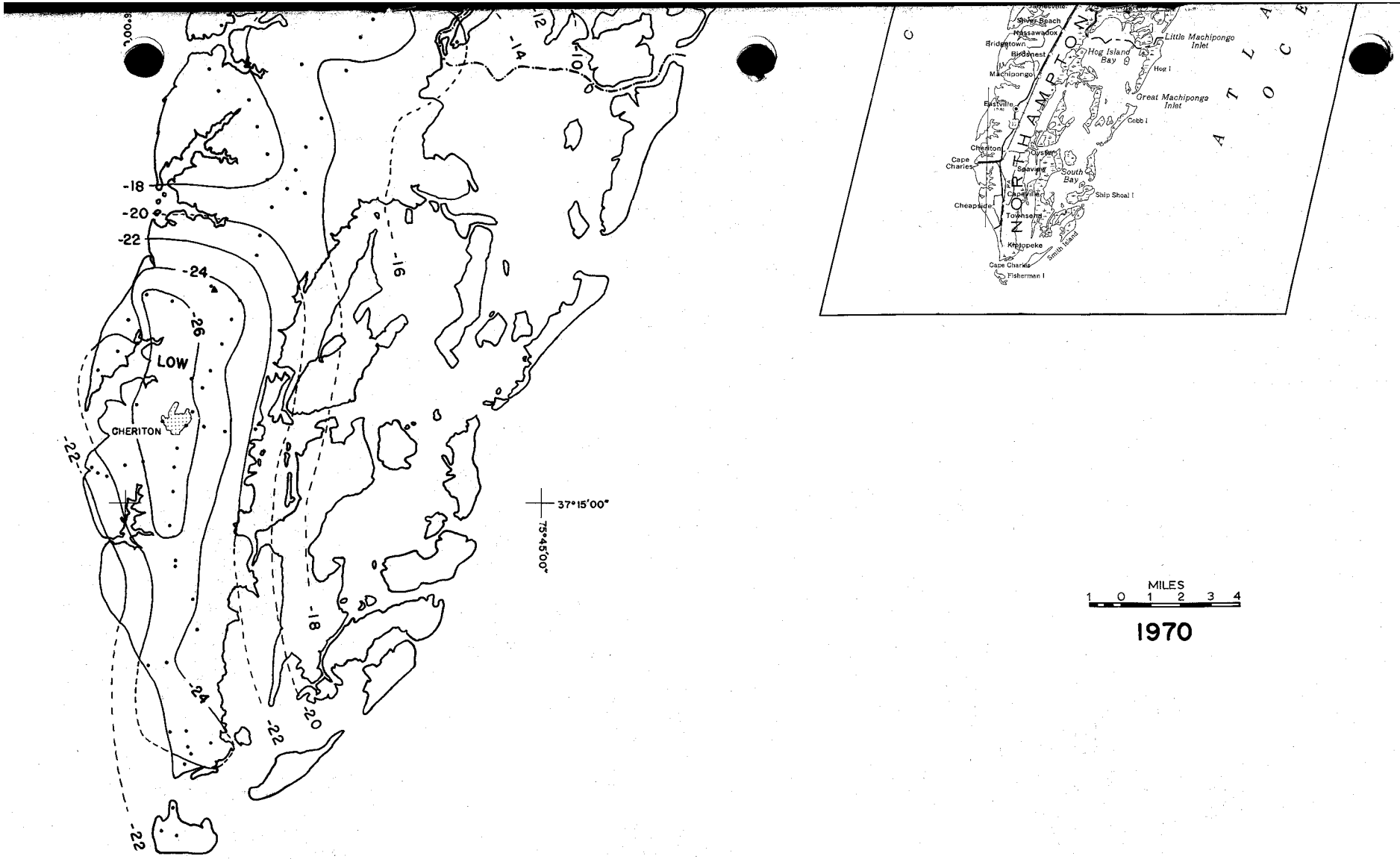


Figure 1. Bouguer gravity map of Northampton and Accomack counties, Virginia, prepared by Stanley S. Johnson and Palmer C. Sweet.

of Ocean City, drilled by Standard Oil Company of New Jersey to a depth of 7710 feet, bottomed in the Lower Cretaceous (Richards, 1967, p. 2415).

ACKNOWLEDGEMENTS

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REFERENCES

American Geophysical Union and U. S. Geological Survey, 1964, Bouguer gravity anomaly map of the United States (exclusive of Alaska and Hawaii): U. S. Geol. Survey, scale 1:2,500,000.

Balsley, J. R., and others, 1946, Magnetic maps of Worchester County and part of Wicomico County, Maryland: U. S. Geol. Survey Oil and Gas Inv. (Prelim.) Map 46.

DeBuchananne, G. D., 1968, Ground-water resources of the Eastern Shore of Virginia and the James, York, and Rappahannock river basins of Virginia east of the Fall Line: U. S. Geol. Survey Hydrol. Inv. Atlas HA-284.

Le Van, D. C., and Pharr, R. F., 1963, A magnetic survey of the Coastal Plain of Virginia: Virginia Division of Mineral Resources Rept. Inv. 4, 17 p.

Richards, H. G., 1967, Stratigraphy of Atlantic Coastal Plain between Long Island and Georgia, review: Am. Assoc. Petroleum Geologists Bull., vol. 51, no. 12, p. 2400-2429.

Steenland, N. C., 1951, Results of interpretation of six aeromagnetic surveys, in Vacquier, V., and others, Interpretation of aeromagnetic maps: Geol. Soc. America Mem. 47, p. 9-41.

U. S. Naval Oceanographic Office, 1967, Total magnetic intensity, Atlantic coastal region: U. S. Naval Oceanog. Office, Sheet 6, H. O. Series 17507.

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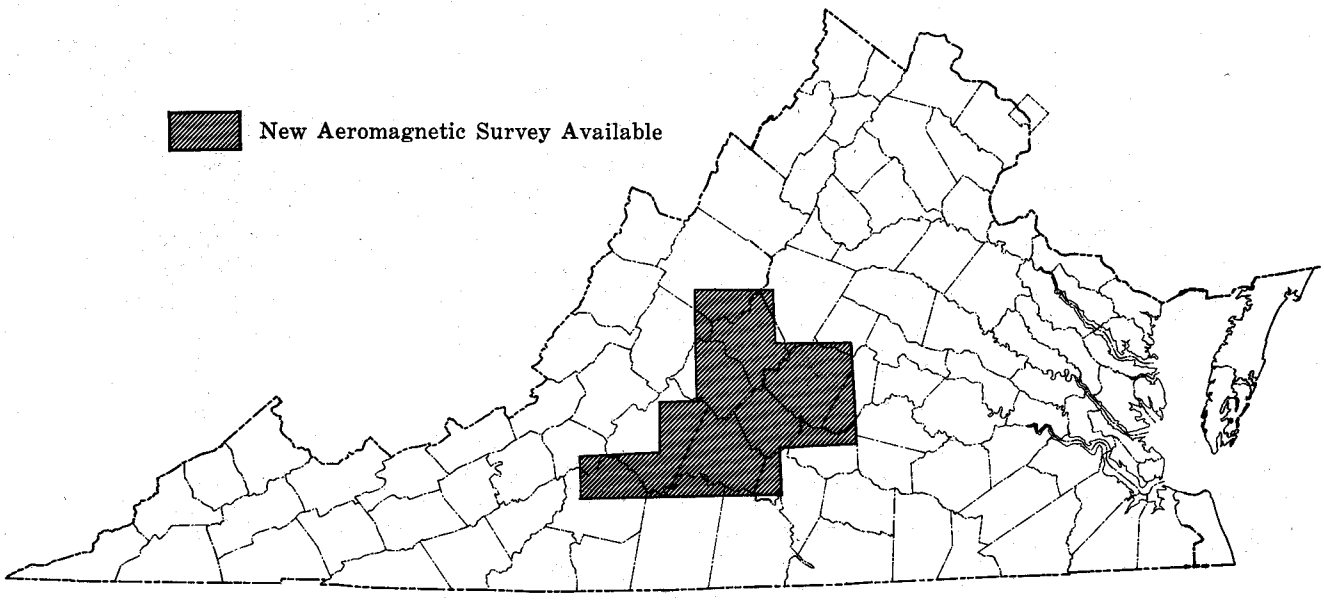
AEROMAGNETIC SURVEY OF CENTRAL VIRGINIA AVAILABLE

An aeromagnetic survey that covers approximately 3840 square miles in central Virginia will be released on August 10, 1970 by the Division of Mineral Resources. This survey includes all or portions of Albemarle, Amherst, Appomattox, Augusta, Bedford, Buckingham, Campbell, Charlotte, Cumberland, Fluvanna, Franklin, Halifax, Nelson, Pittsylvania, Prince Edward, Roanoke, and Rockbridge counties. Magnetic variations were recorded by airborne magnetometer at an altitude of 500 feet above ground level. Basic traverses were flown in east-west lines with one-half mile spacing, and control lines were flown at right angles to these.

The information is compiled on topographic quadrangle maps at a scale of 1:62,500, or 1 inch



equals approximately 1 mile, and total magnetic intensity is contoured at intervals of 20 and 100 gammas. The following 15-minute quadrangles are included: Altavista, Amherst, Appomattox, Boones Mill, Brookneal, Buckingham, Dillwyn, Farmville, Gladys, Goode, Lovingston, Lynchburg, Moneta, Pamplin City, Shipman, and Vesuvius. This aeromagnetic survey adjoins the northern boundary of a previous one made in 1969.

The contour maps, on open file August 10, in the Division's library at Charlottesville, will be available for reference use. Ozalid copies, available for purchase at a cost of $5.00 plus $0.20 tax per 15-minute quadrangle, may be ordered from the Virginia Division of Mineral Resources, Box 3667, Charlottesville, VA 22903.

NEW PUBLICATIONS

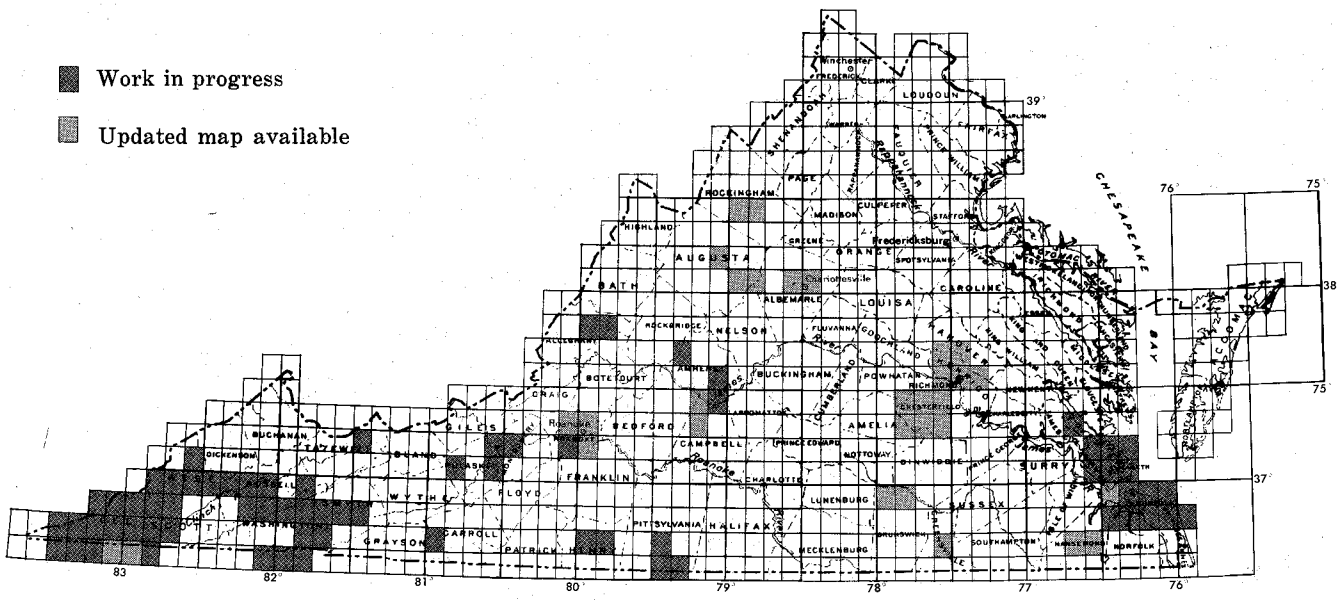
Report of Investigations 21. GEOLOGY OF THE ELLIOTT KNOB, DEERFIELD, CRAIGSVILLE, AND AUGUSTA SPRINGS QUADRANGLES, VIRGINIA, by Samuel J. Kozak; 23 p., 4 maps in color. Price: $4.50 (plus 4 percent State sales tax).

Report of Investigations 22. GEOLOGY OF THE PHILPOTT RESERVOIR QUADRANGLE, VIRGINIA, by James F. Conley and William S. Henika; 46 p., 2 maps (1 in color). Price: $2.75 (plus 4 percent State sales tax).

DIRECTORY OF THE MINERAL INDUSTRY IN VIRGINIA—1970, by D. C. Le Van; 46 p. Price: $0.25 (plus 4 percent State sales tax).

LIST OF PUBLICATIONS (1970), 48 p. Free.

UPDATED 7.5-MINUTE TOPOGRAPHIC MAPS



Updated maps, on which recent cultural changes are indicated, are now available for certain areas. These changes noted from inspection of aerial mapping photographs are overprinted in magenta on existing maps. These are available at 50 cents each from the Virginia Division of Mineral Resources, Box 3667, Charlottesville, VA 22903.

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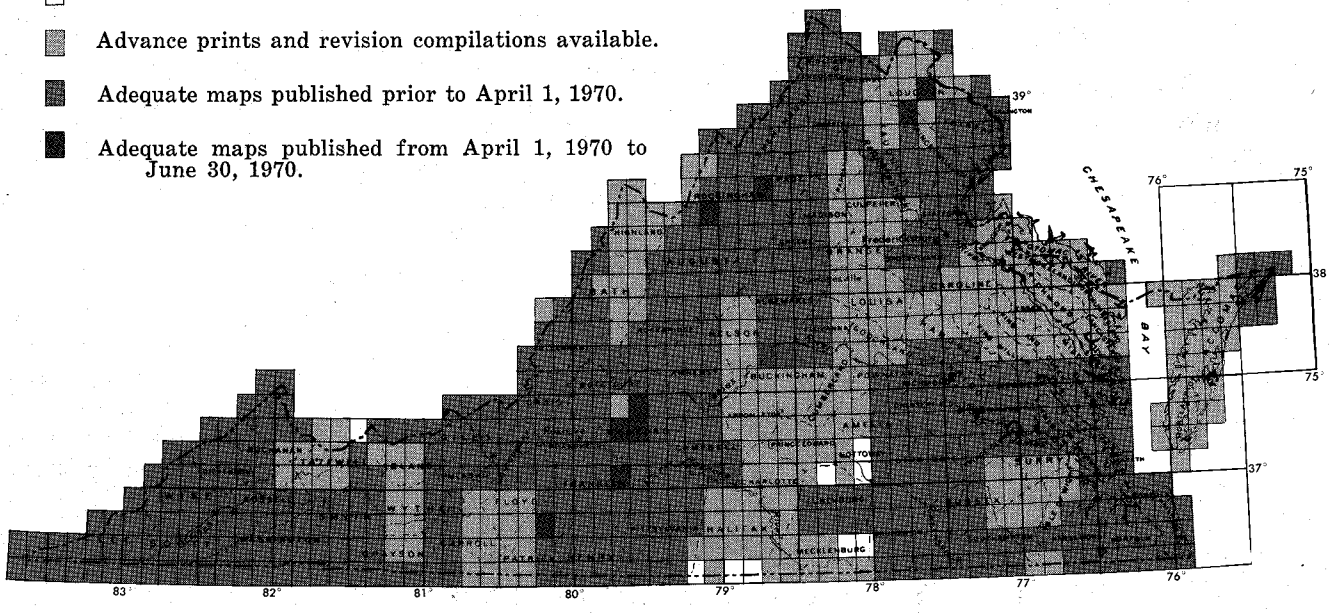
PROGRESS OF TOPOGRAPHIC MAPPING

The following statistical compilation and status maps indicate the progress of the modern 7.5-minute quadrangle topographic mapping program through June 30, 1970.

	Number of Quadrangles	Percent of State
Number of quadrangles	805	100
Mapping in progress	9	1
Preliminary maps available	274	34
Modern maps published	522	65
Total number of available maps	796	99

- In preparation—map not yet available.
- Advance prints and revision compilations available.
- Adequate maps published prior to April 1, 1970.
- Adequate maps published from April 1, 1970 to June 30, 1970.



ADVANCE PRINTS AND REVISION COMPILATIONS

Advance prints and copies of revision compilations are available at 50 cents each from the U. S. Geological Survey, Topographic Division, 1109 N. Highland St., Arlington, VA 22210.

PUBLISHED MAPS

State index is available free. Published maps are available at 50 cents each from the Virginia Division of Mineral Resources, Box 3667, Charlottesville, VA 22903.