U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
WEST VIRGINIA GEOLOGICAL AND ECONOMIC SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I–2364–H
SHEET 2 OF 2

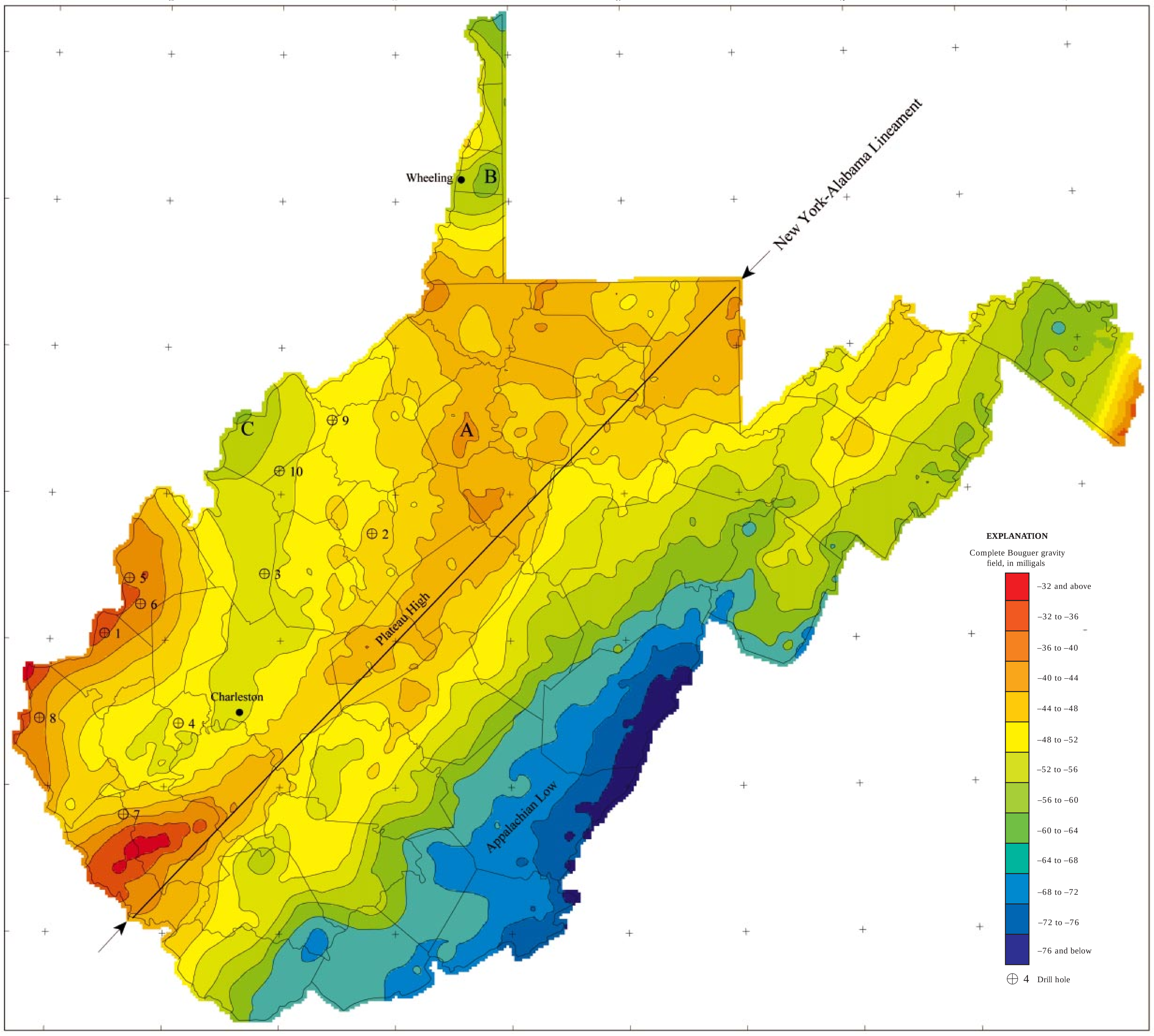

Figure 3. Complete Bouguer gravity anomaly map of West Virginia showing county boundaries, location of drill holes penetrating basement rocks shown in table 1, and anomalous features (labeled) or areas (lettered A, B, and C) discussed in text.

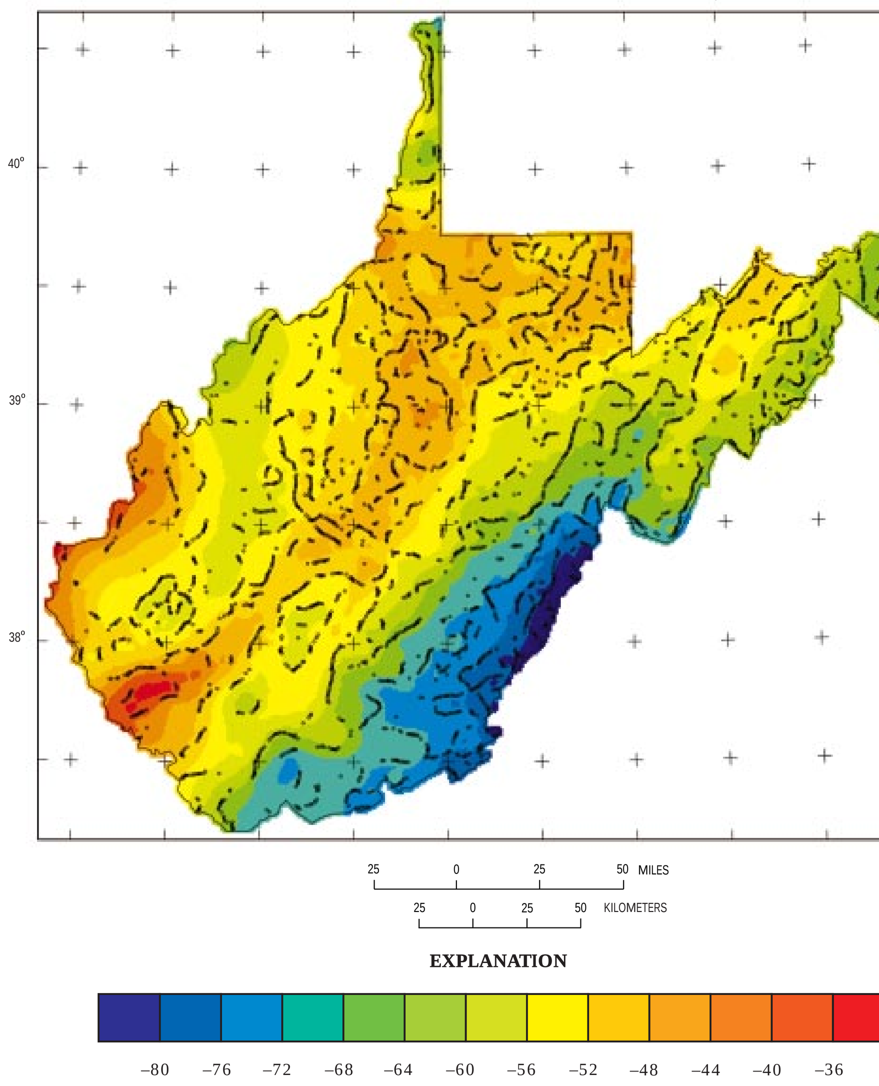

Figure 6. Complete Bouguer gravity map showing gravity boundaries outlining subsurface areas of anomalous density in West Virginia. Symbols mark solutions of boundary calculations using method of Blakely and Simpson (1986).

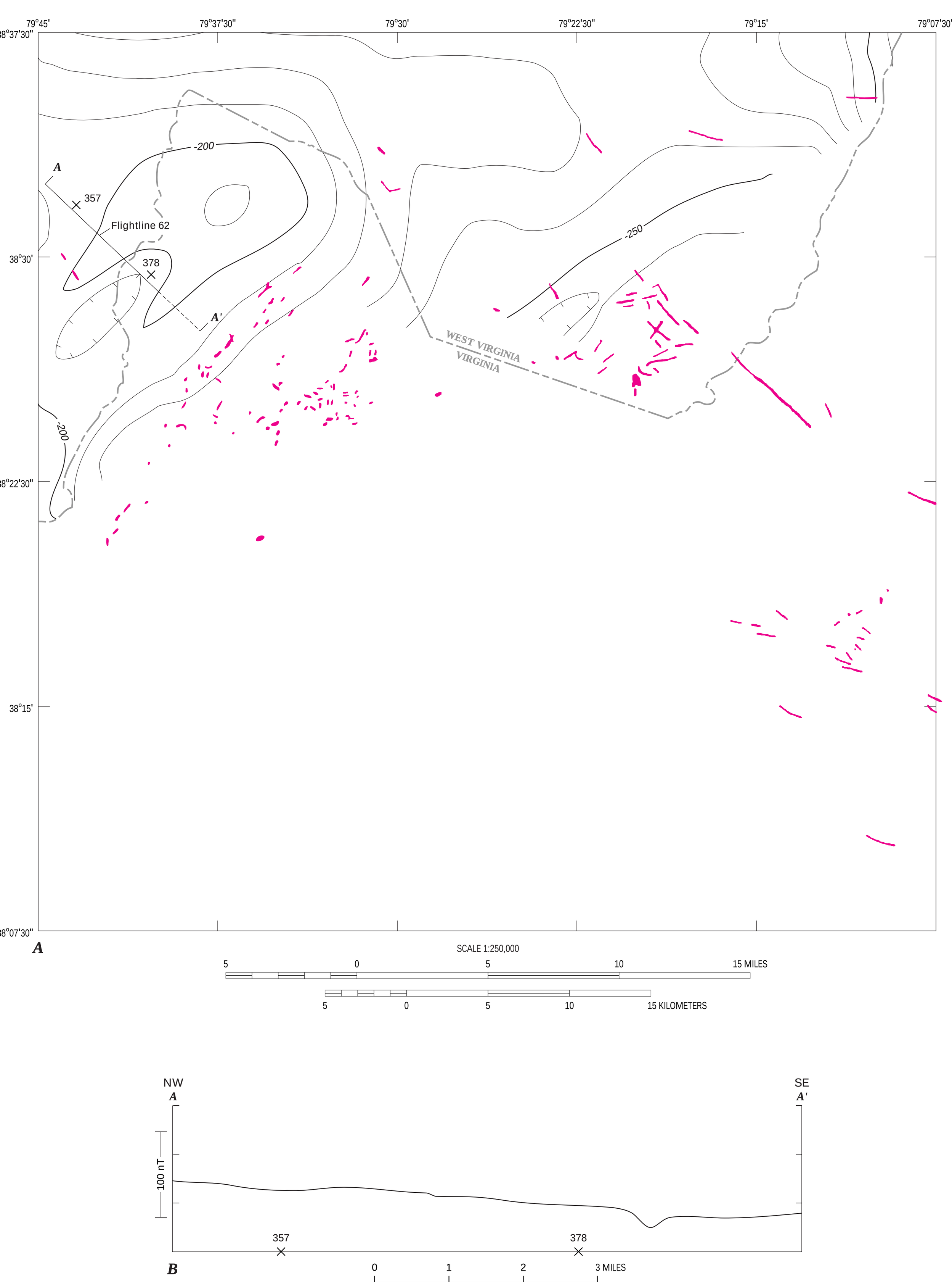

Figure 7. Comparison of aeromagnetic data to dikes and small intrusive bodies along the West Virginia–Virginia border. *A*, aeromagnetic contour map (from U.S. Geological Survey, 1978) and dikes and intrusions (shown in pink; from Johnson and others, 1971). Contour interval 10 nT. Hachures indicate closed areas of lower magnetic intensity. *B*, profile of magnetic intensity along part of flightline 62 that intersects an inferred dike.

no apparent correlation with the gravity map (fig. 3).

The Charleston magnetic low from the Ohio border south to 38° N. latitude coincides with a broad gravity slope from about -50 to -58 mGal. This area may be underlain by a belt of relatively nonmagnetic metasedimentary rock. This correlation is supported by data from drill hole 2, (fig. 2 and table 1), which is the only drill hole that penetrated a gneiss of probable sedimentary origin, indicated by the presence of graphite and sillimanite.

Southeast of the New York–Alabama lineament, gravity and magnetic patterns show little correlation, with one or two notable exceptions. Magnetic and gravity values are both generally low. The gravity low is part of the regional Appalachian low that extends from New England to Alabama. The lowest gravity values are along the Virginia and West Virginia border, trend to the northeast, and parallel structures of the Appalachian system. In contrast, most magnetic trends are north or north-northeast. The two major magnetic lows are the north-trending one along 81° N. longitude and the more extensive one to the east that trends north-northeast toward the Maryland-Pennsylvania boundary. The poor correlation between the magnetic and gravity maps southeast of the New York–Alabama lineament suggests that the magnetic patterns are related to variations in the crystalline basement rocks, whereas the gravity patterns are related to density variations in the overlying sedimentary rocks.

The major magnetically high area south of the New York–Alabama lineament, the New River high, (fig. 2), overlaps a gravity gradient (fig. 3). This may reflect magnetic basement rocks of average density.

A notable correlation of magnetic and gravity highs in the easternmost part of West Virginia (D, figs. 2 and 3) occurs in the only place in the state where Precambrian rocks are exposed. These anomalies correlate with the metabasalts of the Late Proterozoic Catoctin Formation on the west limb of the Blue Ridge anticlinorium (Espenshade, 1970).

Basement Relief

Depth to basement is known only at a few locations in West Virginia where ten deep drill holes have penetrated Precambrian igneous and metamorphic rocks (fig. 2 and table 1). None of these drill holes is east of the New York–Alabama lineament. Only one hole in Virginia reached basement southeast of the lineament.

Several contour maps of the basement surface under the Appalachian basin have been prepared by using stratigraphic projections from wells penetrating the lower Paleozoic section. In the series to which this map belongs, the basement surface was derived from seismic reflection profiles (Pohn, 1994). Although all these maps show a general agreement in the western part of the state, they vary considerably in the eastern part, particularly where the basin is the deepest. In the basement map of North America (American Association of Petroleum Geologists and U.S. Geological Survey, 1967) the basement slopes east-southeast to at least 40,000 ft below sea level in eastern Pennsylvania. In the basement map of the United States (Bayley and Muehlberger, 1968), the basement slopes southeast to more than 30,000 ft below sea level in eastern Pennsylvania, and at least 35,000 ft near the southeast border of West Virginia. In Kelley and others (1970) the basement slopes southeast to a northeast-trending series of elongated closed lows near the Blue Ridge; in southern Pennsylvania this series of lows is bordered on the northwest by a broad, shallower basement area that strikes southwest into western Maryland and West Virginia. In an inset on the geologic map of West Virginia (Cardwell and others, 1968), H.P. Woodward inferred that the southeast-sloping basement is modified by a series of discontinuous reversals in gradient southeast of a postulated zone of transcurrent faulting that trends east-northeast from the Kentucky River fault zone of northeast Kentucky to the bend in the Appalachian fold belt near the 40th parallel (fig. 1). In all these maps, a south-facing scarp or series of steps from the Kentucky River fault zone extends eastward into southern West Virginia. A depositional trough of Cambrian age, the Rome trough, in which clastic rocks predominate, has been delineated from drilling in Kentucky and West Virginia. The northwestern margin of this trough is shown as a series of steps facing southeast toward the deepest part of the trough in a basement map by Harris (1975). The Rome trough broadens as it continues northeast into southwestern Pennsylvania. Seismic reflection data indicate that the trough is asymmetric and bounded on the southeast by a steep rise of more than 7,000 ft in the basement east of Charleston. In the gravity map (fig.3) this steep side of the Rome trough is delineated by a continuous northwest-sloping gradient aligned with the -48 mGal contour. In the south, this gradient trends westward into Kentucky, and north of Charleston it trends northeast along the boundary of the inferred plutonic area west of location A. The southeast side of the Rome trough also is apparent along the east flank of the Charleston magnetic low between Charleston and 39° N. latitude (fig. 2).

SUMMARY

The magnetic and gravity anomaly maps of West Virginia help define the basement complex of plutonic and metasedimentary rocks, many of which are strongly magnetic. These basement rocks are overlain by a large volume of Paleozoic sedimentary rocks of the Appalachian basin, which contribute significantly to the gravity anomalies.

The New York–Alabama lineament (King and Zietz, 1978) is the largest, most conspicuous structural feature of the magnetic map. This extensive linear, northeast-trending alignment of gradients transects the entire state and defines a fundamental discontinuity in the basement rocks.

The magnetic and gravity maps have a broad similarity. Both maps show lower fields to the southeast that rise to a northeast-trending ridge that transects the central part of the state. This ridge broadens to a triangular shape near Pennsylvania. Another area of gravity and magnetic highs is present in the westernmost part of the state. Drill holes penetrating the basement in these two areas support the interpretation that the highs are caused by plutonic terranes.

The Charleston magnetic low and the corresponding broad gravity slope probably mark the presence of a belt of metasedimentary rock separating the two inferred plutonic terranes. This conclusion is supported by the presence of metasedimentary gneiss retrieved from a drill hole in the basement.

Southeast of the New York–Alabama lineament, there is a notable lack of correlation between the magnetic and gravity anomalies. The magnetic anomalies generally follow the dominant trend of the basement lithologic units. Density variations in these units are apparently minor. Thus, we conclude that most of the basement rocks southeast of the New York–Alabama lineament are of intermediate composition.

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Table 1. *Data for deep drill holes that penetrate Precambrian (p€) basement rocks, West Virginia.*

[Well cuttings, logs, and file data from R.T. Ryder, U.S. Geological Survey; DMS = degrees, minutes, seconds; locations shown in figure 2]

No. on map	County, permit number	Drill hole name	Lat (DMS)	Long (DMS)	Surface altitude (ft)	Depth to p€ (ft)	Total depth (ft)	Altitude of p€ (ft)	Depth in p€ (ft)	Lithology of Precambrian basement
1	Cabell, 537	Cyclops Corp. #1 E. Kingery	383121	821548	667	8,490	8,552	-7,823	62	Quartz-feldspar-biotite (minor hornblende-magnetite) gneiss.[1]
2	Calhoun, 2503	Exxon Corp. #1 Gainer-Lee	385205	810609	1,230	20,051	20,222	-18,821	171	Quartz-oligoclase-biotite gneiss containing garnet, graphite, sillimanite.[1]
3	Jackson, 1366	Exxon Corp. #1 W.J. McCoy	384347	813415	943	17,620	17,675	-16,677	55	Gneiss and granite layer.[1]
4	Lincoln, 1469	Exxon Corp. #1 D.E. McCormick	381303	815621	737	18,919	19,124	-18,417	205	Cuttings: tonalite-granodiorite.[2]
5	Mason, 69	United Fuel #1 G. Arrington	384243	820929	609	8,588	8,635	-7,979	47	Hornblende gneiss[3] and syenite.[4]
6	Mason, 297	Union Drilling, Inc. #1 R.L. Jividen	383724	820632	626	10,564	10,598	-12,640	34	No sample.
7	Mingo, 805	Columbia Gas Transmission Co. #1 Tract 10	375418	821019	958	19,570	19,600	-18,612	30	Granodiorite and minor quartz monzonite and tonalite; shearing; K/Ar biotite age 939±34 Ma.[5]
8	Wayne, 1572	Exxon Corp. #1 J.P. Smith	381348	823224	594	14,590	14,625	-13,996	35	"Precambrian granite."[6]
9	Wood, 351	Hope Nat. Gas Co. #1 Power Oil Co. (Sandhill)	391518	811617	1,050	13,272	13,331	-12,260	55	Banded gneiss of granodiorite, tonalite, and amphibolite[7]; Rb/Sr biotite age 870 Ma.[8]
10	Wood, 756	Exxon Corp. #1 H.H. Deem	390450	813030	694	13,254	13,266	-12,560	12	Granite gneiss.[1]

[1]Lithologic log: R.T. Ryder (U.S. Geological Survey, unpub. data).
[2]Petrographic analysis of thin section of cuttings by Louis Pavlides (U.S. Geological Survey, oral commun., 1992).
[3]Summerson (1962).
[4]McGuire and Howell (1963).
[5]Heald (1981).
[6]Schweitering and Roberts (1988).
[7]Bass (1959).
[8]Bass (1960).

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By
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