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GEOPHYSICAL LOGS AND COAL SECTIONS OF HOLES DRILLED DURING 1977 AND 1978 IN THE BROWNS HILL QUADRANGLE, CARBON COUNTY, WYOMING

By

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INTRODUCTION

The purpose of this report is to present data obtained during a 1977-78 U.S. Geological Survey coal drilling program in the Little Snake River coal field along the eastern margin of the Washakie Basin, Carbon and Sweetwater Counties, Wyo. Also presented are data from privately drilled holes, including one water well.

A total of 14 holes were drilled for the USGS in Tps. 13-15 N., Rs. 89-90 W., in the Browns Hill quadrangle, in the southeastern part of the Little Snake River coal field (figs. 1-6), during September 1977 and July-August 1978. This drilling was done to obtain information on the depth, thickness, and extent of coal in the Almond Formation and the marine member of the Allen Ridge Formation, and is part of a project to evaluate and classify federally owned coal resources and lands in the Little Snake River coal field and adjacent areas.

Drilling was done in 1977 with a privately owned and operated truck-mounted rotary drilling rig; in 1978 USGS rigs were used. Most drilling was done with roller-cone rock bits. Thick intervals of claystone were commonly drilled with drag bits. Drilling fluids generally used were air and water. Air was used to depths where drill cuttings became too sticky from formation water to be blown from the hole. Then water or, in some instances, water containing a biodegradable foaming agent, was injected with compressed air to aid in transport of cuttings to the surface. Bentonitic drilling mud was used in a few holes. In most instances, hole erosion and mixing of cuttings with up-hole debris increased and the quantity and quality of cuttings decreased with increasing depth, formation water, and water injection. During drilling, cuttings believed to be representative of the rock strata were sampled, examined, and sacked. Later, each drill hole was logged by geophysical methods.

ACKNOWLEDGMENTS

Collection and examination of samples and most of the geophysical logging were done by personnel of the USGS. Several holes were also logged for the Survey by a private company.

The author of this report also acknowledges the cooperation of the following residents of the Little Snake River Valley and Rawlins areas in Wyoming who allowed the Survey to drill on their lands and to log private water wells: Richard Boyer of Savery; Clare Dillon, Marjorie Dillon, and Thomas Grieve of Dixon; and Robert Stratton, Vern Vivion, Joseph Wenger, and Bertha Wenger of Rawlins.

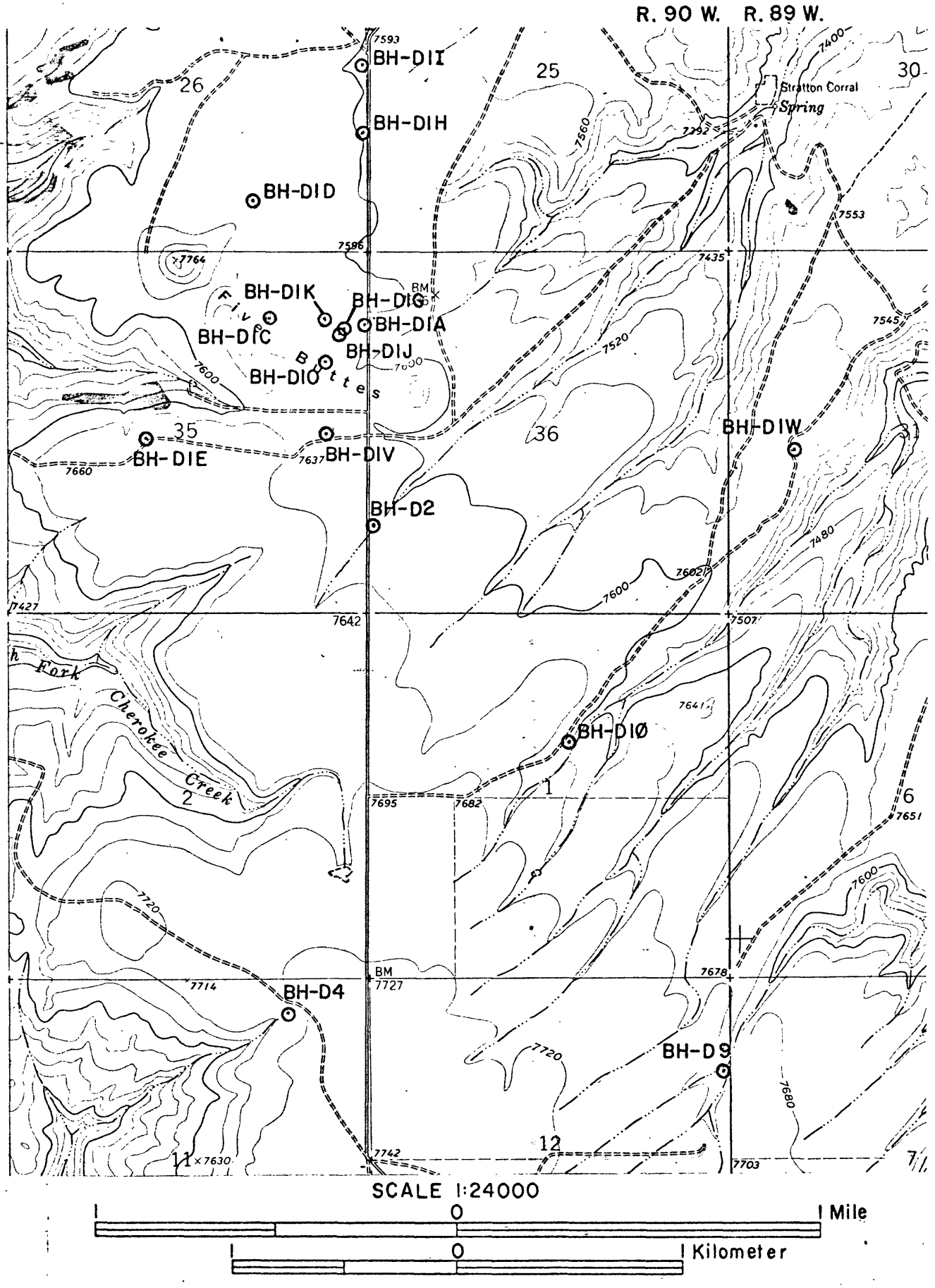

Figure 1.--Location map for holes drilled in 1977 in the northwestern part of the Browns Hill quadrangle, Carbon County, Wyo.

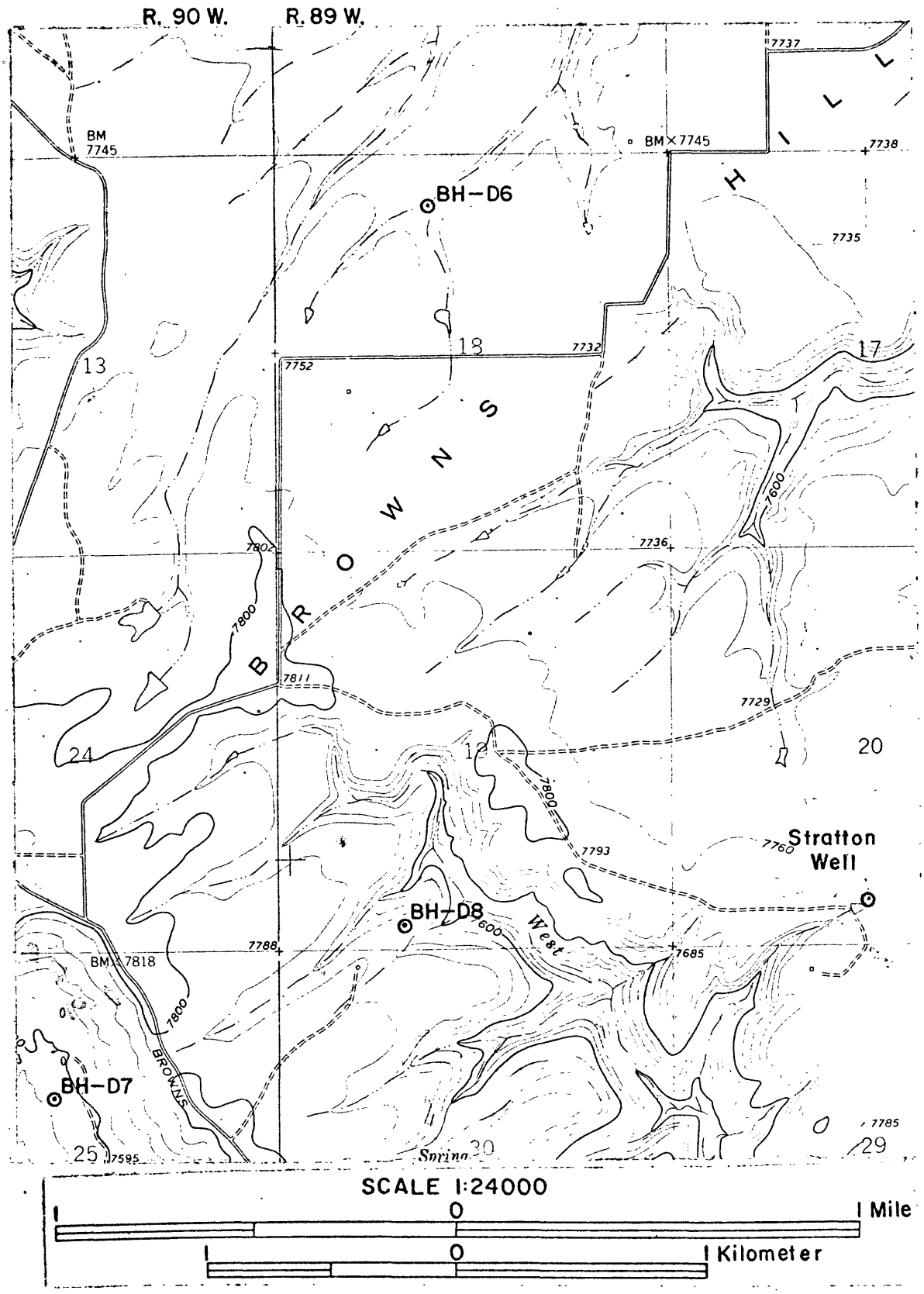

Figure 2.--Location map for holes drilled in 1977 in the southwestern part of the Browns Hill quadrangle, Carbon County, Wyo.

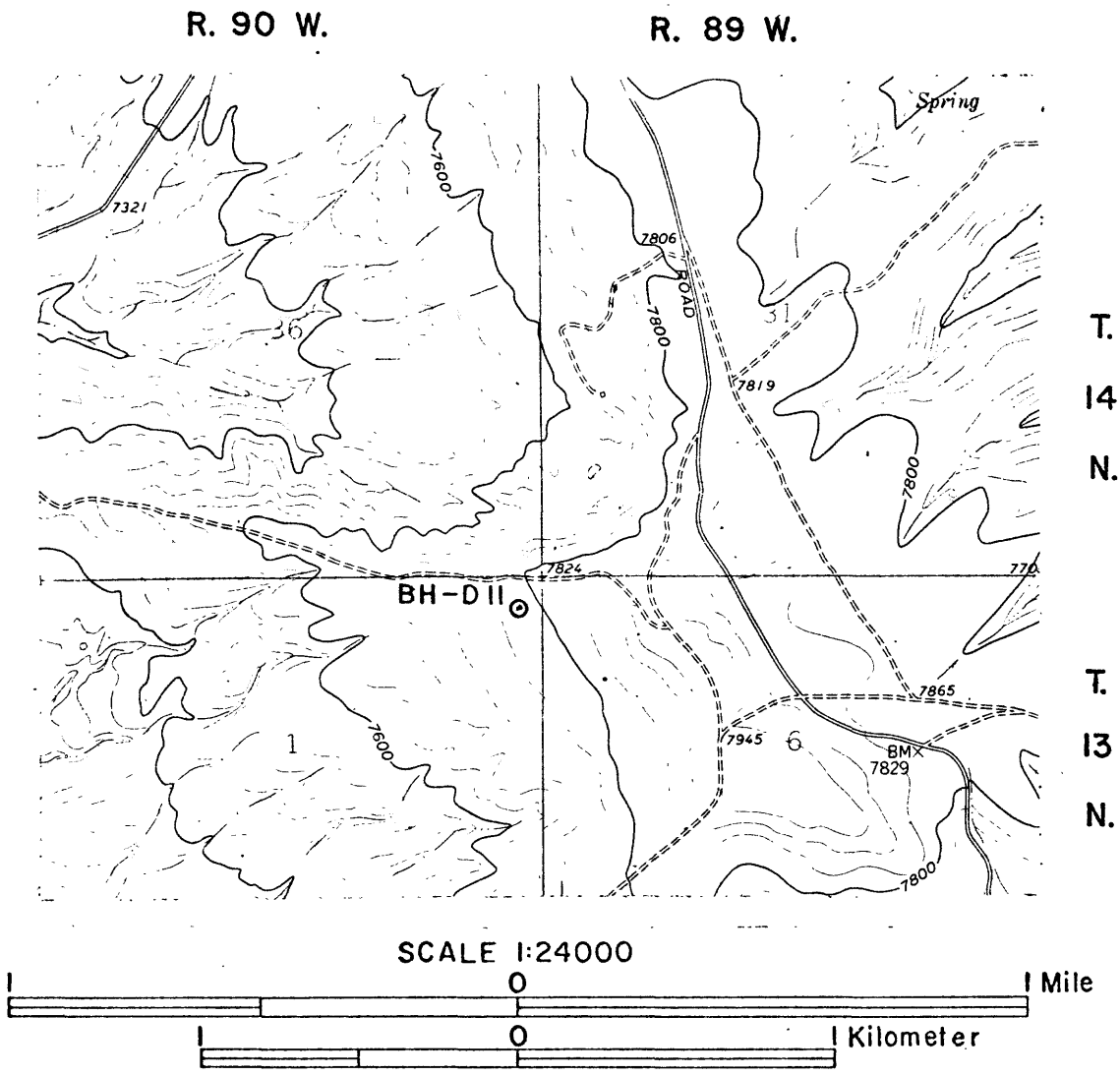

Figure 3.--Location map for hole BH-D11 drilled in 1978 in the southwestern part of the Browns Hill quadrangle, Carbon County, Wyo.

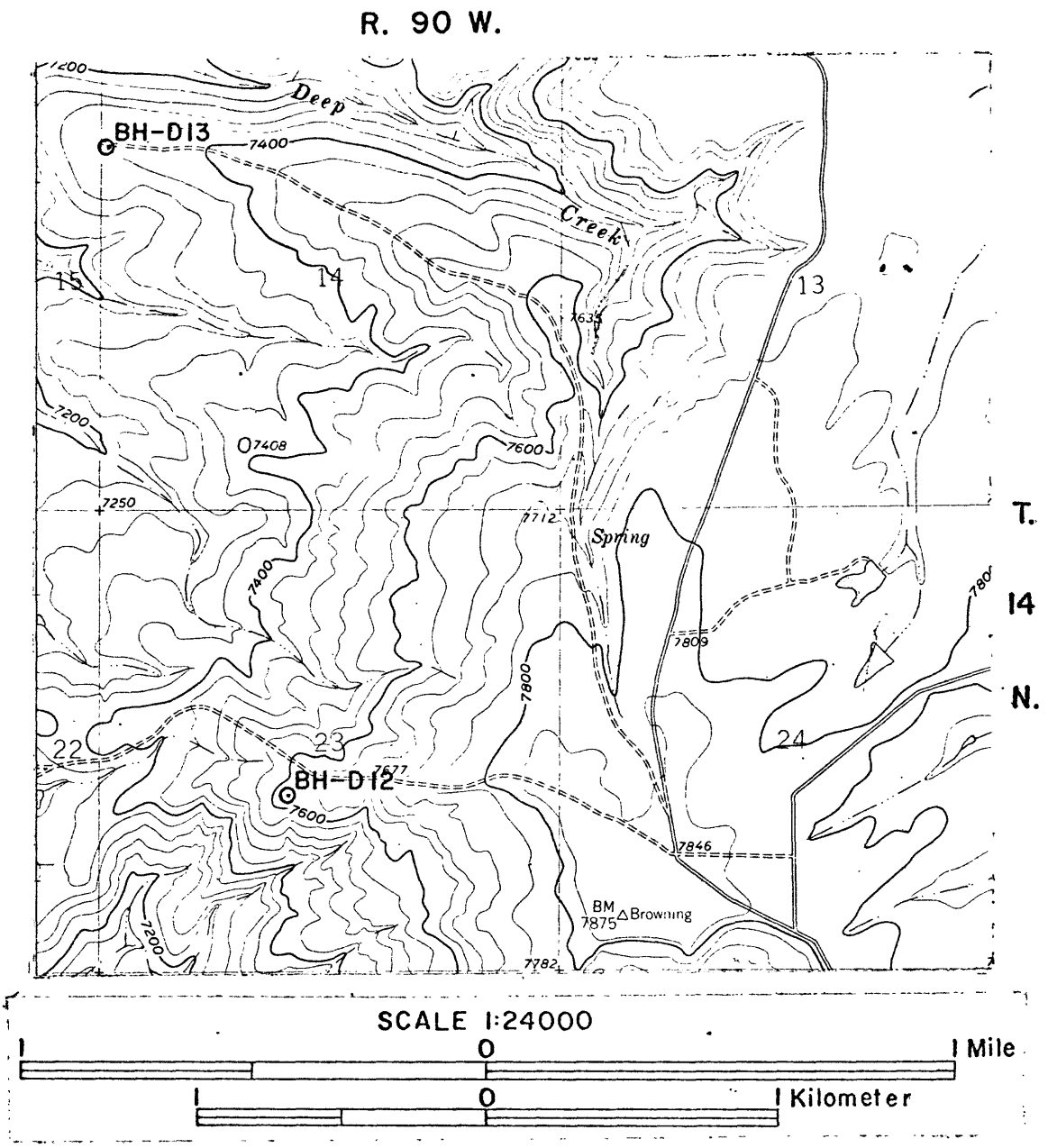

Figure 4.--Location map for holes BH-D12 and BH-D13 drilled in 1978 in the southwestern part of the Browns Hill quadrangle, Carbon County, Wyo.

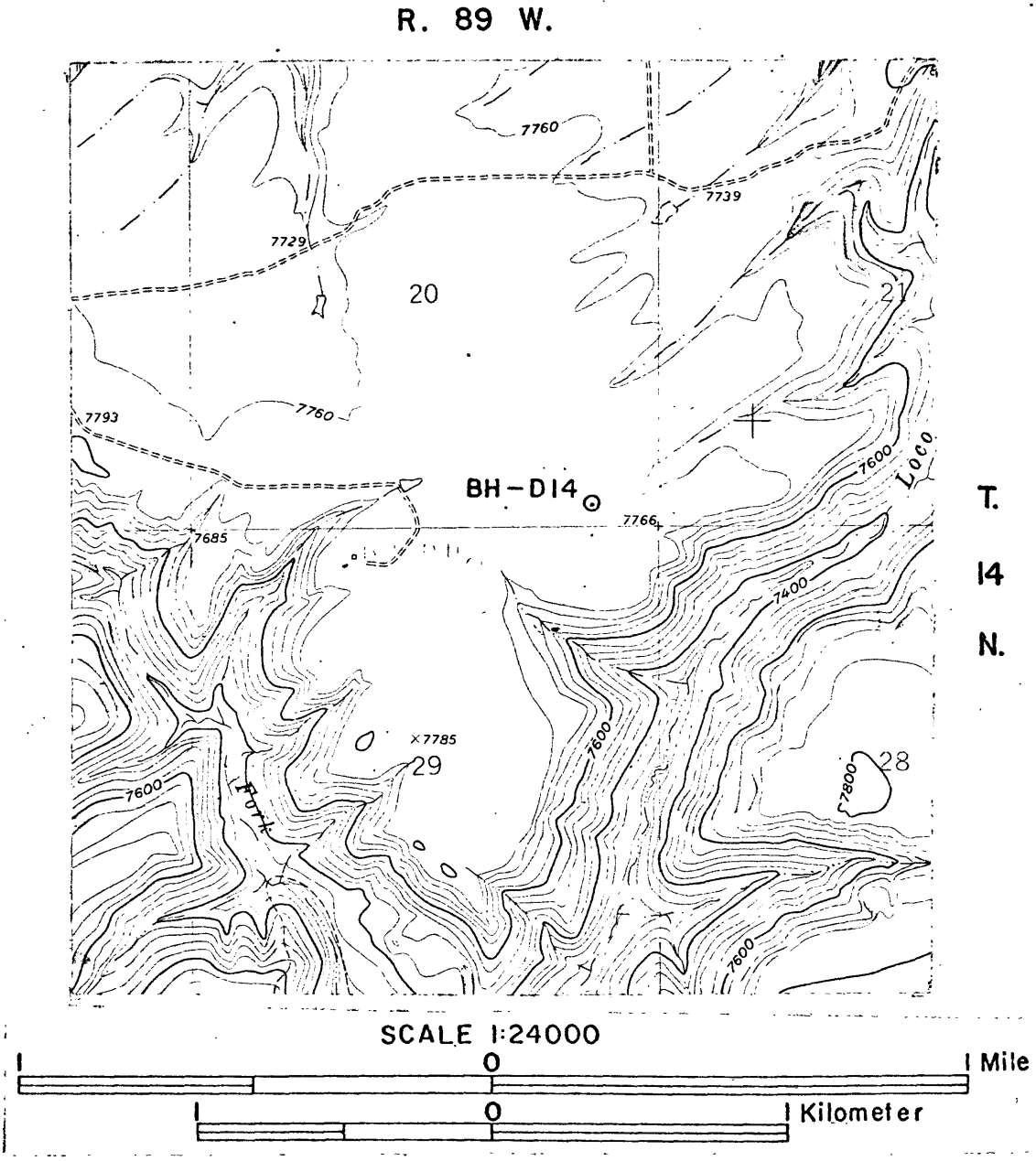

Figure 5.--Location map for hole BH-D14 drilled in 1978 in the south-central part of the Browns Hill quadrangle, Carbon County, Wyo.

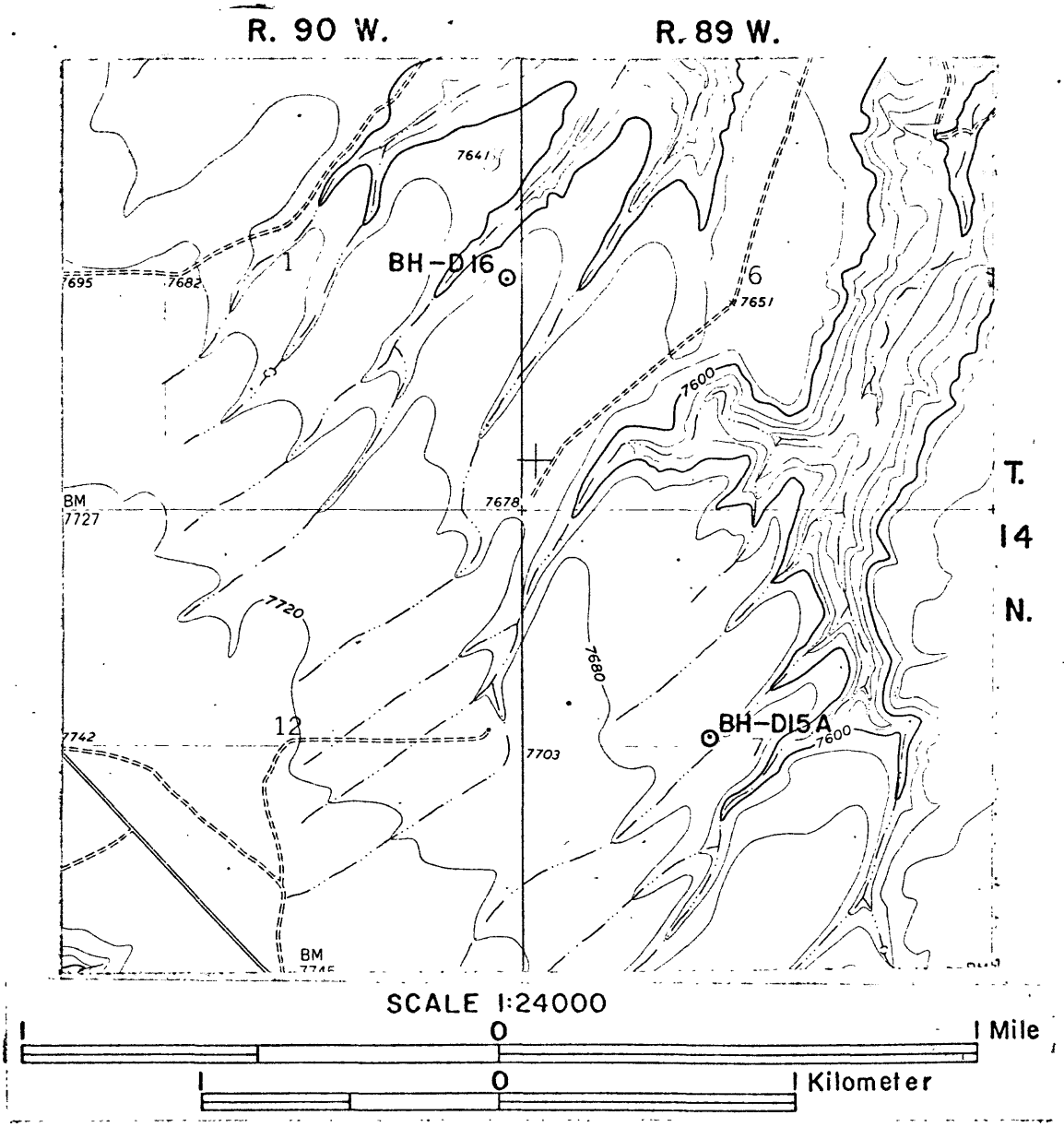

Figure 6.--Location map for holes BH-D15A and BH-D16 drilled in 1978 in the northwestern part of the Browns Hill quadrangle, Carbon County, Wyo.

STRATIGRAPHY OF THE DRILLED ROCK FORMATIONS

Rock strata and sediments intersected by the drill holes belong to the Mesaverde Group and the overlying Lewis Shale, both of Late Cretaceous age; the Browns Park Formation of probable Miocene age; and unconsolidated surficial deposits of Quaternary age. Correlations of stratigraphic units between drill holes are shown in figure 7.

In southern Wyoming the Mesaverde Group consists of, in ascending order, the Haystack Mountain Formation, the Allen Ridge Formation, the Pine Ridge Sandstone, and the Almond Formation (Gill and others, 1970, p. 5). The Haystack Mountain Formation, which was not intersected in any of the drill holes discussed in this report, is a marine and marginal marine formation and overlies the Upper Cretaceous marine Steele Shale.

The Allen Ridge Formation is largely composed of continental fluvial sequences of sandstone, siltstone, mudstone, and thin carbonaceous shale and coal beds. In most places in the Little Snake River coal field the uppermost part of the Allen Ridge consists of marginal marine lagoonal-paludal deposits of thick, bioturbated organic-rich brown shales, thin sandstone beds, and coal. The lower nonmarine member of the Allen Ridge Formation is estimated to be 1,000-1,200 ft (305-366 m) thick and the uppermost marginal marine member, 170-210 ft (52-64 m).

The Pine Ridge Sandstone is a continental fluvial deposit consisting of sandstone and a subordinate amount of carbonaceous siltstone and mudstone. According to Gill, Merewether, and Cobban (1970, p. 30), the Pine Ridge is probably unconformable on the Allen Ridge in most places in southern Wyoming. The thickness of the Pine Ridge is difficult to determine in many parts of the Little Snake River coal field because its contacts with sub- and superjacent formations are not well known. In most areas of the Little Snake River coal field, the Pine Ridge is believed to be 40-100 ft (12.2-30.5 m) thick. In the Five Buttes area, in the northwestern part of the Browns Hill quadrangle, it is 40-60 ft (12.2-18.3 m) thick.

The Almond Formation is largely composed of marginal marine deposits. In most places, the lower part is characterized by thick coal beds associated with both marine and nonmarine sandstone beds, and the upper part by shale and sandstone deposited by alternating transgressive and regressive cycles, respectively, of a Late Cretaceous western interior sea. The Almond Formation is about 450 ft (137 m) thick in most parts of the Little Snake River coal field. In drill-hole BH-D4 it is about 500 ft (152 m) thick.

In some places in the southeastern part of the Little Snake River coal field, the Pine Ridge Sandstone may be absent. In such places, the marginal marine lagoonal-paludal deposits normally included in the Allen Ridge cannot be separated from similar deposits in the lower part of the Almond and are included in the Almond Formation. In one such area near Savery, the Almond may be as much as 930 ft (283 m) thick, and characteristically has a thick areally persistent, marine sandstone bed, informally referred to as the sandstone of Loco Creek, at the base (Barclay and Shoaff, 1978, p. 8). The sandstone of Loco Creek, which crops out in the bluffs bordering Loco Creek in the southeastern part of the Browns Hill quadrangle, can be traced

north-northwestward into areas where the Pine Ridge is recognized and, therefore, becomes the base of the marine member of the Allen Ridge Formation. The sandstone of Loco Creek can definitely be recognized in logs of drill-holes BH-D6, BH-D7, BH-D14, and BH-D15A.

Drill-holes BH-D6 and BH-D7 intersect the sandstone of Loco Creek in the depth intervals 394-420 ft (120-128 m) and 847-890 ft (258-271 m), respectively. If the Pine Ridge is absent in BH-D7, the Almond is about 820 ft (250 m). If the sandstone in the interval 617-660 ft (188-201 m) is the Pine Ridge, the Almond is about 545 ft (166 m) thick, and the marine member of the Allen Ridge is about 230 ft (70 m) thick. In BH-D6, the interval 170-208 ft (52-63 m), which is composed of sandstone and some associated finer grained rocks, probably is the Pine Ridge Sandstone, and the marine member of the Allen Ridge Formation is about 212 ft (65 m) thick.

The Lewis Shale is 2,000-2,500 ft (610-762 m) thick in the Little Snake River coal field and consists of marine shale and, in the upper part, sandstone. The thickest interval of the Lewis that was penetrated was 344 ft (105 m) in BH-D11. The Lewis Shale is overlain by the marine Fox Hills Sandstone, which was not intersected in any of the drill holes.

The Browns Park Formation is present in many parts of the Little Snake River coal field where it lies with angular unconformity on all older formations. It is nonmarine and consists mostly of sandstone, although in most places it has a thick basal conglomerate. Near the Wyoming-Colorado border, in the southeastern part of the Little Snake River coal field, it may be as much as 1,600 ft (488 m) thick.

Beds of the Browns Park were intersected in most of the drill holes in the Browns Hill quadrangle. The thickest interval of Browns Park that was drilled was about 70 ft (21.3 m) of sandstone and conglomerate in BH-D14. Natural gamma logs (figs. 16, 22, 24, 25, 28, and 37, this report; and Barclay and Shoaff, 1977, fig. 31) of some drill holes show that uranium mineralization may be associated with the unconformity between the Browns Park and Almond Formations in the Five Buttes area in the northwestern part of the quadrangle.

Most of the drill holes were started in bedrock or thin soils. A few holes intersected unconsolidated clay-silt and sand and/or gravel deposits of Quaternary age. The thickest Quaternary deposit drilled is a landslide deposit of about 16 ft (4.9 m) of mud and gravel overlying the Lewis Shale in BH-D7.

STRUCTURE NEAR THE DRILL SITES

On the basis of surface measurements near the drill holes, the maximum dip of the Lewis Shale and Almond Formation probably does not exceed 15° WSW. The dip of the Browns Park Formation in most areas is generally believed to be less than 5° NE.

GEOPHYSICAL LOGS

All the drill holes except BH-D12 and BH-D15 were logged by geophysical methods (figs. 10-85). Logs that were run were natural gamma, neutron, gamma-gamma, single-point resistance, self-potential (spontaneous potential), 16- and 64-in. normal resistivity, and caliper. Drill-holes BH-D12 and BH-D15 were abandoned at shallow depths, about 50 ft (15.2 m) and 20 ft (6.1 m), respectively. The Lewis Shale was the only formation penetrated in BH-D12, and conglomerate of the Browns Park Formation was the only formation drilled in BH-D15. Drill-hole BH-D15, which is not shown on any of the location maps in this report, was drilled about 25 ft (7.6 m) west of BH-D15A (fig. 6).

Calibration curves relating porosity and density to counts per second on the neutron and gamma-gamma logs, obtained with well reconnaissance logger W-236265, are given in figures 8 and 9, respectively. The calibration curves are for water-filled holes and can only be applied to those portions of the logs which were obtained below water level. The calibration curves cannot be used to determine actual porosity or density in coal. The neutron tool measures water-filled porosity by measuring the amount of hydrogen present. Coal, because it is composed largely of hydrocarbon, gives a false porosity value. The calibration curve for the gamma-gamma tool was calibrated in material of densities between 1.65 and 2.65 gm/cc and is probably not accurate for bituminous or subbituminous coals of the Mesaverde Group, which presumably have densities in the range of 1.3-1.5 gm/cc.

COAL IN THE DRILLED FORMATIONS

Coal beds occur in the Almond Formation, and in both the marine and nonmarine members of the Allen Ridge Formation. Coal in the Mesaverde Group in the Little Snake River coal field was formerly thought to be bituminous (Ball and Stebinger, 1910, p. 202), but recent studies show that, although it may be medium volatile bituminous in deep (near 10,000 ft or 3,048 m) parts of the Washakie Basin, it is generally subbituminous A-B in near-surface (less than 500 ft or 152 m) beds (Hatch and Barclay, 1979).

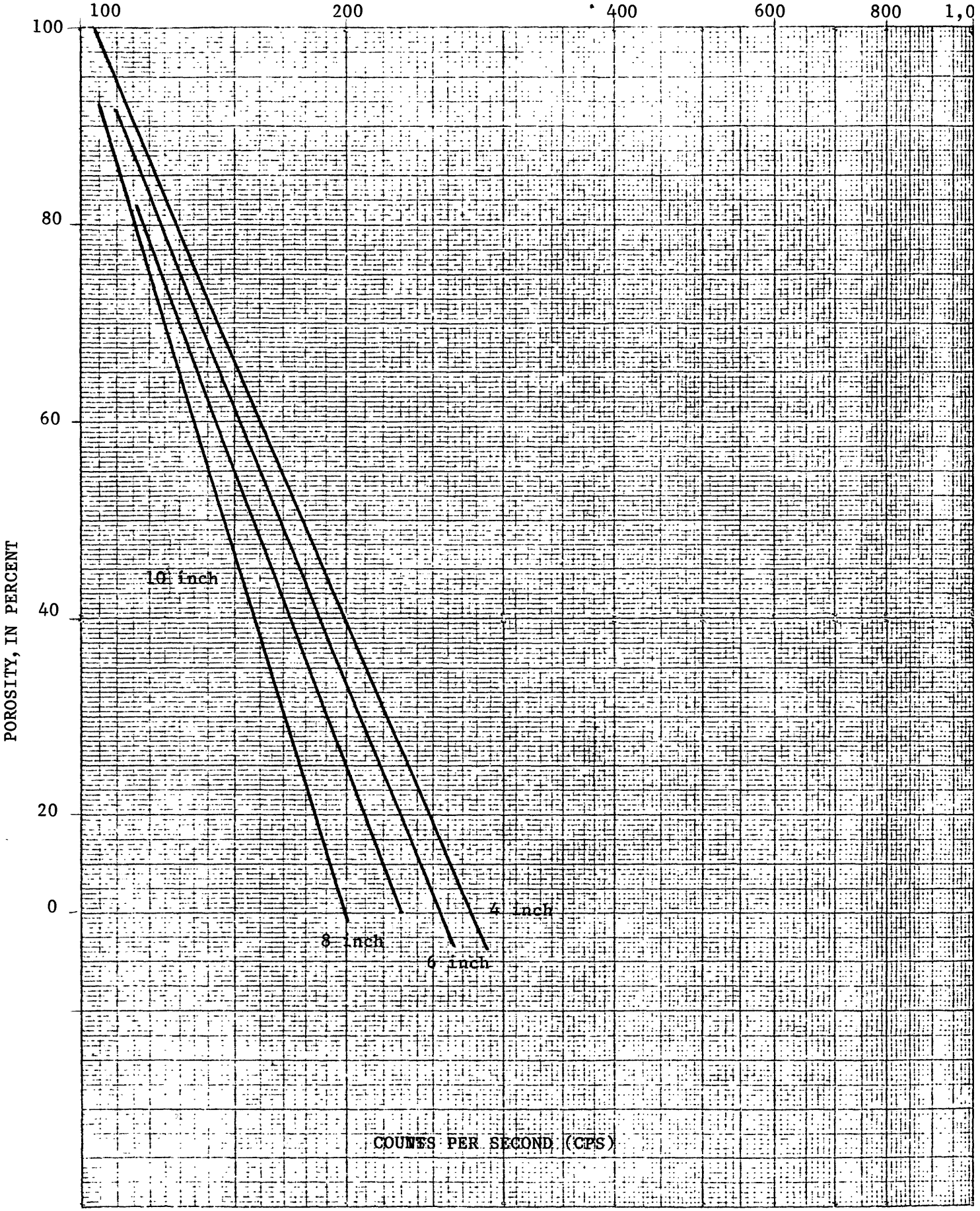

Figure 8.--Calibration curve for neutron log, well reconnaissance logger W-236265: 4-, 6-, 8-, and 10-inch water-filled drill holes.

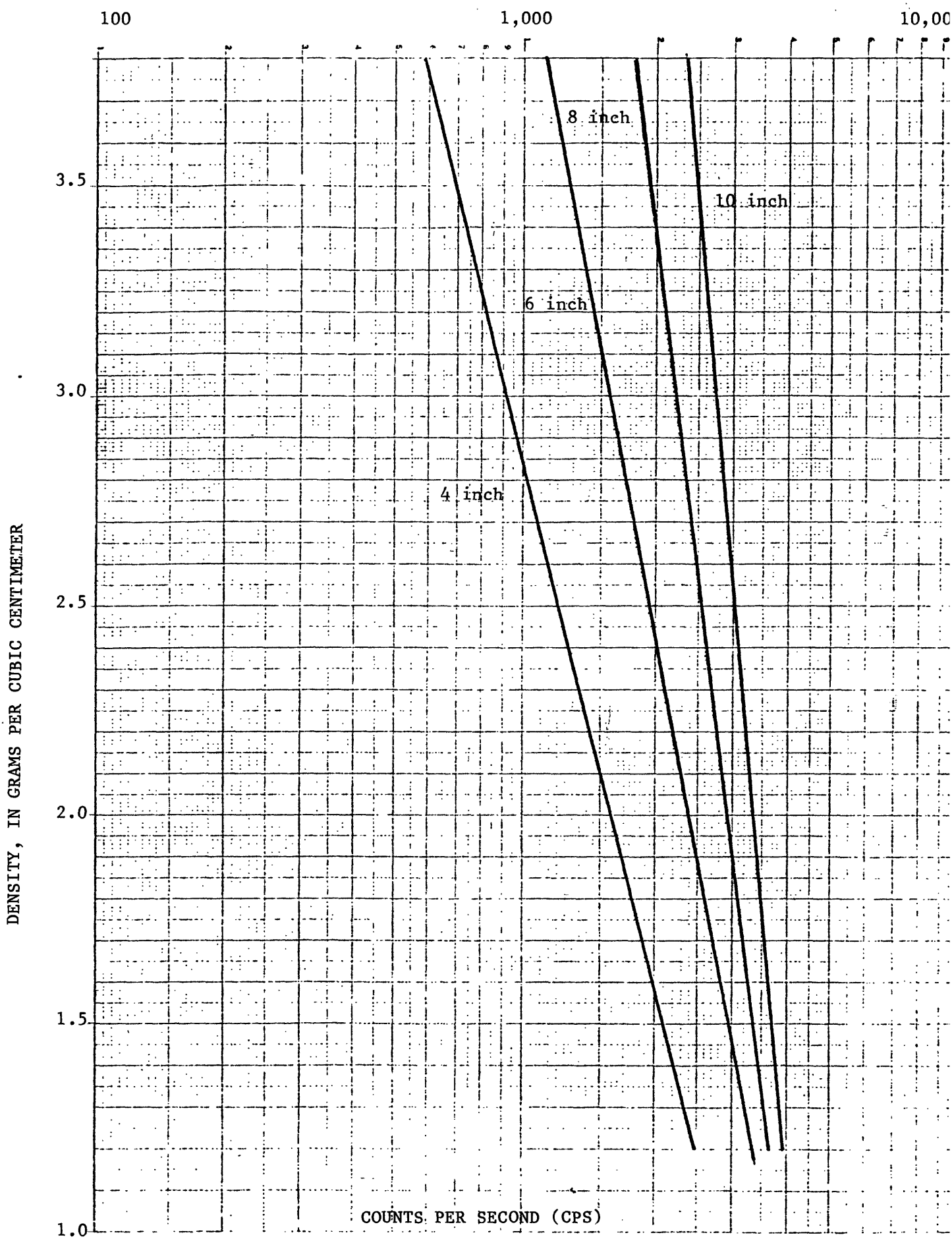

Figure 9.--Calibration curve for gamma-gamma log, well reconnaissance logger W-236265: 4-, 6-, 8-, and 10-inch water-filled drill holes.