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UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
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PAMPHLET

MINERAL RESOURCE POTENTIAL OF THE CORNPLANTER ROADLESS AREA, WARREN COUNTY, PENNSYLVANIA

By

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Studies Related to Wilderness

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and the Joint Conference Report on Senate Bill 4, 88th Congress, the U.S. Geological Survey and the U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primitive areas. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. The act directs that the results of such surveys are to be made available to the public and be submitted to the President and the Congress. This report discusses the results of a mineral survey of the Cornplanter Roadless Area, Allegheny National Forest, Warren County, Pa. The area was classified as a further planning area (09031) during the Second Roadless Area Review and Evaluation (RARE II) by theU.S. Forest Service, January 1979.

SUMMARY

The Cornplanter Roadless Area of about 3,000 acres (1,220 ha) in the Allegheny National Forest, Warren County, Pa., contains flat-lying sedimentary rocks of Paleozoic age that have a high potential for gas and a moderate potential for oil. Other mineral resources having low economic potential include salt, various rocks suitable for road metal, conglomeratic sandstone suitable for high-silica uses, and shale suitable for the production of structural clay products. No metallic mineral resources have been identified in the area.

The Federal Government owns all surface rights in the area but only 23 percent of the mineral, oil, and gas rights.

INTRODUCTION

Cornplanter Roadless Area contains about 3,000 acres (1,220 ha) of the Allegheny National Forest on the west side of Allegheny Reservoir, Warren County, Pa. (fig. 1). The study area is almost 4 mi (6.4 km) long and 1-1.5 mi (1.6-2.4 km) wide. The north end is less than 0.5 mi (0.8 km) south of the New York-Pennsylvania State line. Warren, Pa., the County Seat, is 12 mi (19 km) southwest of the area. Access to the Cornplanter area is good at the north end which adjoins the road leading to Webbs Ferry public boat launch on the Allegheny reservoir. Along the west side, old logging and oil exploration trails lead to the area from paved or graveled county roads north and east of Scandia. At the south end, the area adjoins Camp Olmstead operated by the Boy Scouts of America. Along the east side, from the Boy Scout Camp as far north as Hooks Brook, the area adjoins the narrow remaining part of Cornplanter Indian Grant.

The study area is part of the Appalachian Plateau physiographic province. The higher altitudes, remnants of the plateau in northeastern Warren County, are narrow ridges about 2,000-2,100 ft (610-640 m) above sea level; the low altitudes are along the Allegheny reservoir where the normal pool level is 1,328 ft (405 m). Most slopes in the area are steep, and a few along the reservoir shore are clifflike. The woods, which are mostly second- and third-growth hardwoods, are for the most part open and easy to traverse.

Previous Investigations

J. F. Carll (1883) mapped Warren County during the Second Geological Survey of Pennsylvania, and Charles Butts (1910) mapped the Warren 15-minute quadrangle just to the west of the study area. Clay and shale resources of Warren County were described by Leighton (1941). The petroleum resources of the Kinzua 15-minute quadrangle which includes the study area have been summarized by Lytle and Goth (1970). Rhodes (1977) prepared an oil and gas report on the study area for the U.S. Forest Service. Heck (1979) estimated the oil and gas potential for the Tracy Ridge Roadless Area, 0.7 mi (1 km) east of the Cornplanter Area and on the east side of Allegheny Reservoir, in testimony concerning the Allegheny Wilderness Act of

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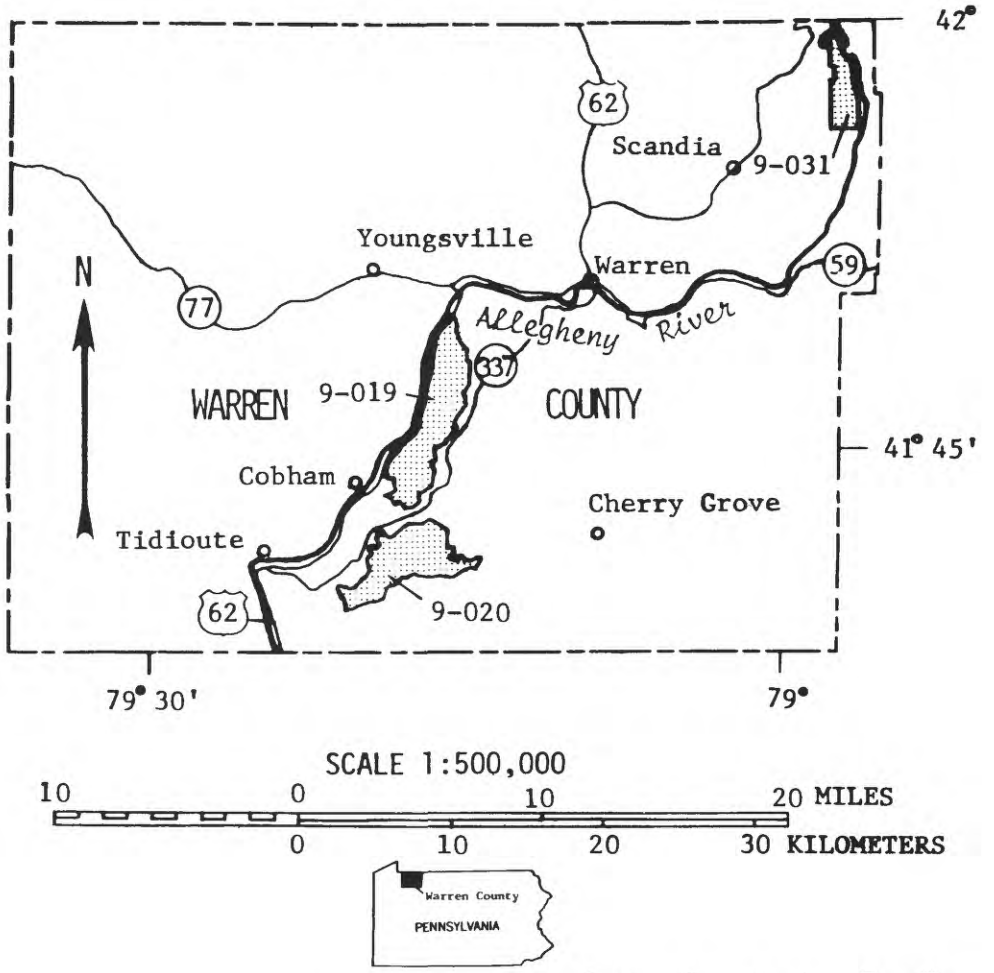

Figure 1.--Index map showing the location of the Cornplanter Roadless Area (9-031). Nearby areas of previous work include the Allegheny Front (9-019) and Hickory Creek (9-020) Roadless Areas (Schweinfurth and others, 1982), the Kinzua quadrangle (Lytle and Goth, 1970), and the Warren quadrangle Butts, 1910). Forest Service area designation numbers shown in parenthesis.

1979. Edmunds (1977) compiled the geology of the Kinzua 15-minute quadrangle in preparation for a new state geologic map. Pomeroy (1981) has made reconnaissance of the landslides and related features in the area.

Present investigation

Lesure, assisted by Andrew E. Grosz, U.S. Geological Survey (USGS), mapped and sampled the area in reconnaissance during three days in October, 1980. J. Thomas Dutro, Jr. (USGS) identified brachiopods in 11 rock samples from the area.

U.S. Bureau of Mines field reconnaissance of the Cornplanter area was conducted in the fall of 1980. Twelve rock samples were collected from the study area for analysis. The U.S. Bureau of Mines Tuscaloosa Research Center, Tuscaloosa, Ala., made preliminary ceramic and bloating tests on five shale samples (Welsh and Grau, 1982, p. 21).

Acknowledgments

The authors gratefully acknowledge the following: Stuart Long,U.S. Army Corps of Engineers, for drill core data; Nils Johnson, U.S. Forest Service, for land status records; and John Harper, Pennsylvania Topographic and Geologic Survey, for oil and gas well records.

SURFACE AND MINERAL OWNERSHIP

The Federal Government owns the surface rights to all of the study area, but owns oil, gas, and mineral rights to only about 750 acres of the study area (fig. 2). Oil, gas, and mineral rights are privately owned on about 1,660 acres of Federal subordinated land, on which extraction is limited by Federal regulations under Title 36, Chapter II, section 251.15. Oil, gas, and mineral rights to about 520 acres of the study area are privately owned and are not affected by these regulations. On one tract of about 85 acres, oil, gas, and mineral ownership is divided 60 percent Federal and 40 percent private. As of June 1981, no oil and gas exploration permit applications had been filed on study area lands.

GEOLOGY

About 800 ft (240 m) of nearly flat-lying clastic marine sedimentary rocks of Late Devonian and Early Mississippian age are poorly exposed in the Cornplanter area (Lesure, 1983), and possibly as much as 9,000 ft (2,745 m) of older Paleozoic sedimentary rocks are present in the subsurface. The oldest exposed formations that form the steep slopes above the Allegheny resevoir pool level are part of the shale, siltstone, and sandstone beds of the Conneaut Group of Chadwick (1935) and overlying Conewango Formation of Late Devonian age. These are overlain by conglomerate and sandstone of the Knapp Formation of Mississippian Age that forms much of the nearly flat upland surface in northeastern Warren County. Large masses of colluvium and old landslides mantle the steep slopes (Pomeroy, 1981). These deposits grade into thin sheets of alluvium along some of the larger stream valleys. A small deposit of glacial outwash is partly exposed in an abandoned gravel pit just above lake level on the toe of a large landslide mass near the north end of the study area.

Bedrock in the study area is nearly flat lying. The Conneaut Group of Chadwick dips about 70 ft/mi (13m/km) to the south in the northern part of the area but levels off and forms two small northeast-trending shallow domes in the southern part of the area near Cornplanter Run (fig. 3). Sandstone beds near the base of the Conewango Formation probably dip about 35 ft/mi (7m/km) to the south, and the base of the Knapp dips about 15-20 ft/mi (3-4 m/km) in the same direction. Faults were not observed during fieldwork, and none has been reported by previous workers.

GEOCHEMISTRY

The U.S. Geological Survey made a reconnaissance geochemical survey of the Cornplanter area to test for indistinct or unexposed mineral deposits that might be recognized by their geochemical halos. Twenty-two stream-sediment, 63 soil, and 23 rock samples were collected and analyzed for 31 elements (Lesure and Day, 1983). The analytical data do not outline any areas of potential metallic mineral resources.

MINERAL RESOURCE POTENTIAL

Oil and gas are the economically important potential mineral resources in Cornplanter Roadless Area. Salt beds present at depth are too thin and buried too deeply to be of economic importance. The other potential mineral resources are shale, sandstone, conglomerate, and sand and gravel, all of which have use as construction materials.

Oil and Gas

The presence of oil and gas in an area depends upon the presence in the subsurface of marine source rocks containing more than one percent organic carbon by weight, on sufficient thermal maturation of the source rocks, on the presence of porous and permeable reservoir rocks capable of containing oil and gas, on the presence of geologic traps in which oil and gas might accumulate, and on the presence of layers of impermeable rock to seal the hydrocarbons in the traps. The more data available about these attributes, the more accurate and objective an appraisal of the oil and gas potential will be.

The Cornplanter Roadless Area lies in the main oil and gas producing region of western Pennsylvania and adjacent southwestern New York where many thousands of wells have been drilled to the shallow Upper Devonian oil and gas sands during the past 123 years. In the general vicinity of the study area, most shallow wells, those less than 2,500 ft deep, were drilled to the east in the area around Bradford, Pa., and Olean, N. Y., or to the west and south in the area around Warren, Kane, and Oil City, Pa. Fifty-seven shallow holes, however, were drilled in or near the Cornplanter area mostly during the 1940's (fig. 4). Five gas wells along Cornplanter Run produced initial gas flows of 50-200 thousand ft^3 (MCF)/day from Upper Devonian sandstones (Rhodes, 1977). A deep test well, Felmont Oil Corporation's #1 Collins, drilled to 4,000 ft in the Hooks Brook area had a show of gas in the shallow Devonian sands. The Appalachian Development Corporation's #1 Williams, which was drilled to a depth of 3,542 ft along the Allegheny River

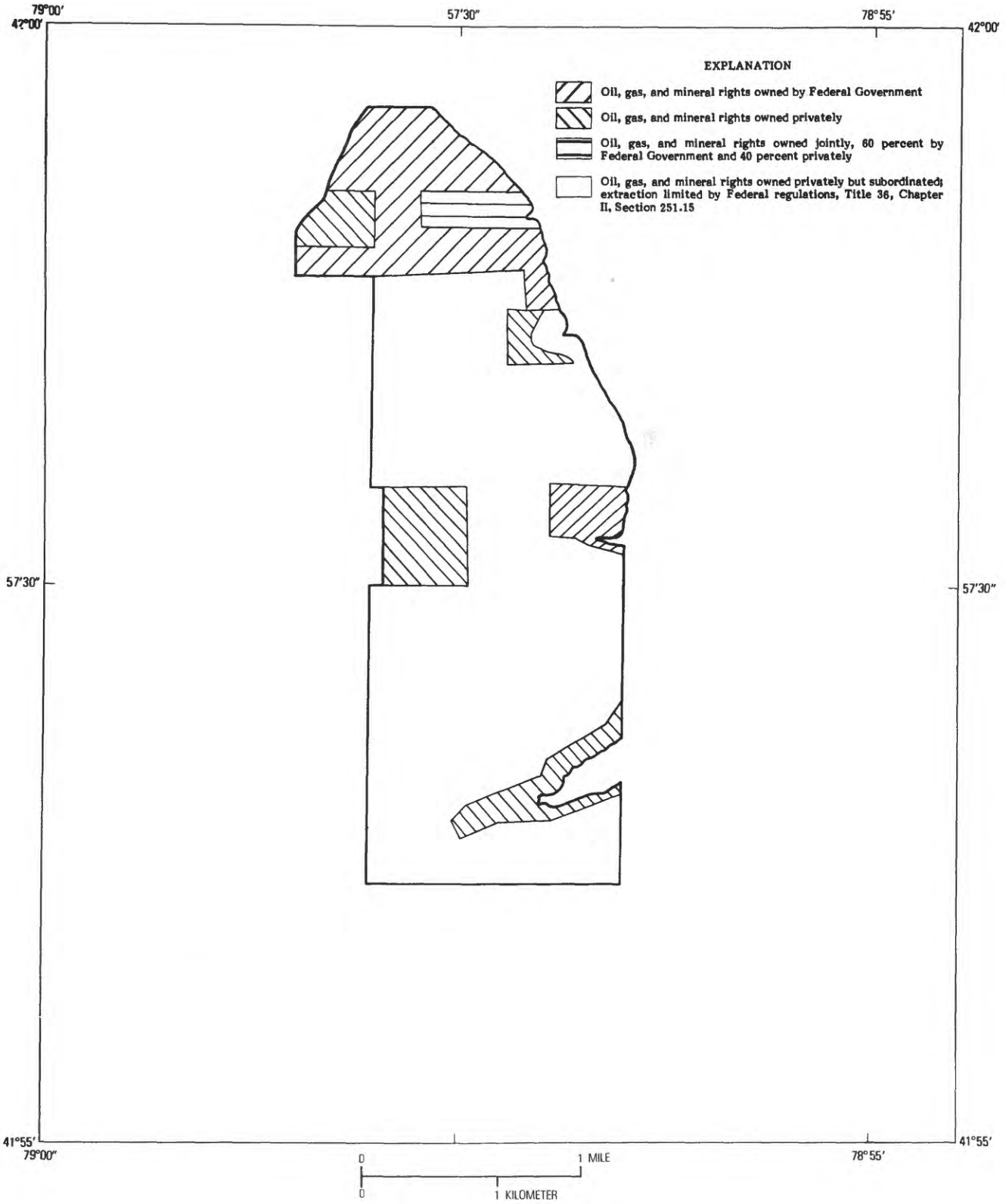

Figure 2.—Map showing oil, gas, and mineral rights ownership in the Cornplanter Roadless Area.

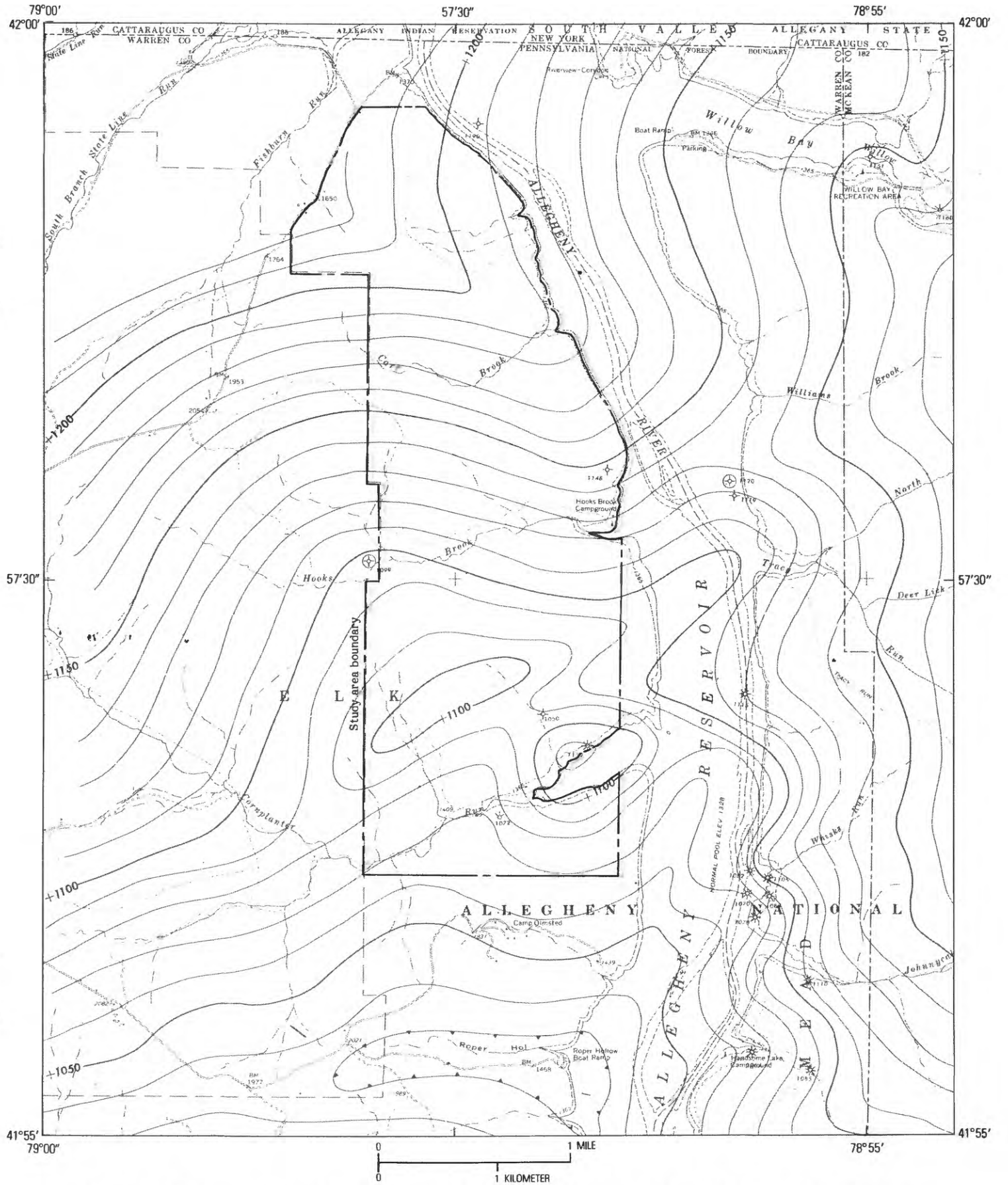

Figure 3.--Structure contours drawn on the base of the "pink rock" a distinctive unit in the Conneaut Group of Late Devonian age. Contour interval 10 ft. From Lytle and Goth, (1970, plate 2).

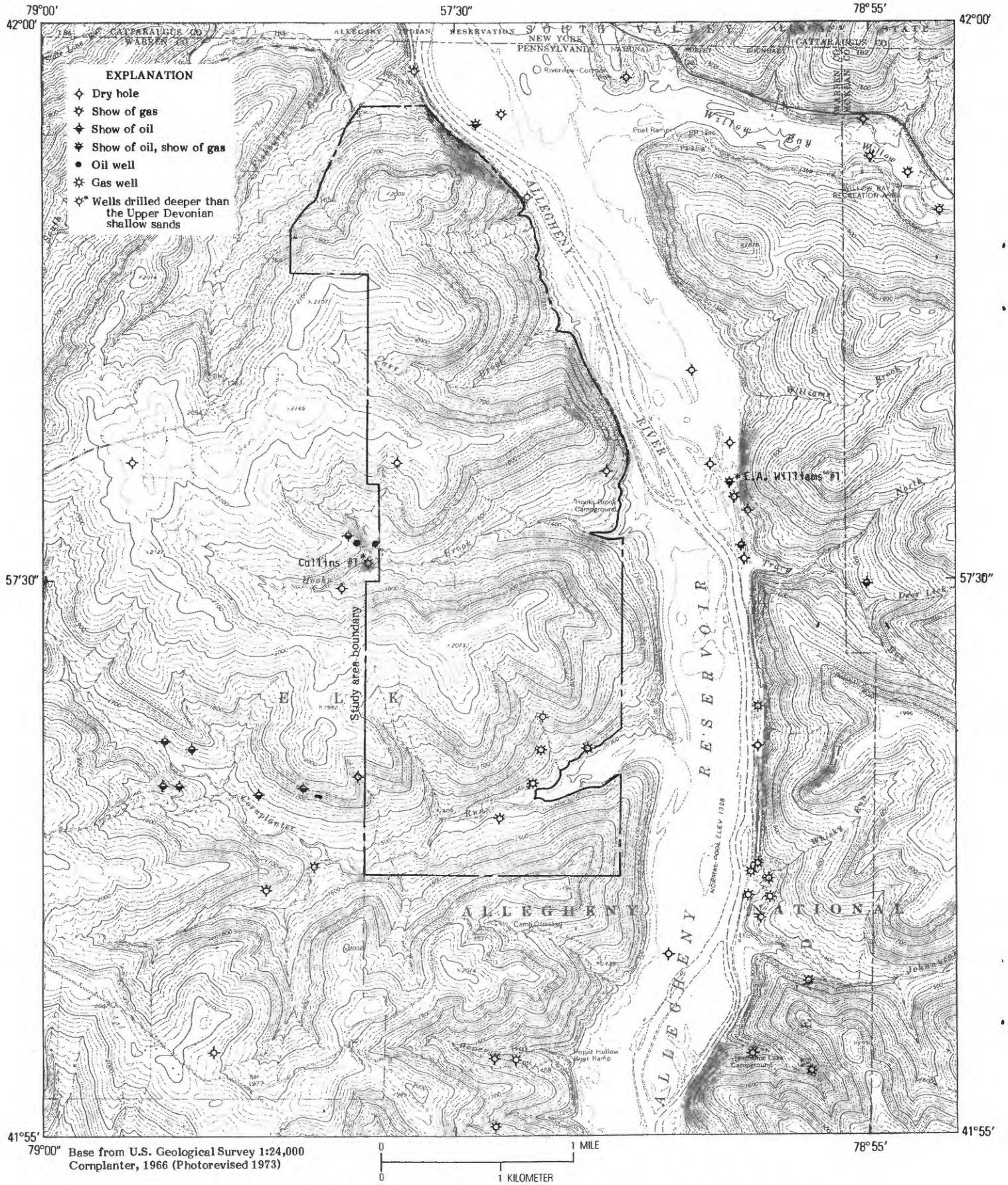

Figure 4.—Oil and gas wells drilled in and near the Cornplanter Roadless Area (after Lytle and Goth, 1970).

just north of the old Cornplanter Indian Reservation, had a small show of oil and three shows of gas in the shallow Devonian sands (Fettke, 1961). At least two wells along Hooks Brook near the western boundary of the study area (fig. 4), produced oil (Lytle and Goth, 1970 pl. 1). All oil and gas wells in the study area have been abandoned for more than 15 years.

Unfortunately for the purposes of petroleum appraisal only scant and fragmentary data are available from most of the old wells which were drilled by cable-tool methods in the interval from 1860 to 1940. The location and production records for individual wells are largely nonexistent. A few detailed studies of drill cuttings (Fettke, 1961) from deep exploratory wells in the Warren-Bradford area greatly augment the scattering of shallow-well data in and adjacent to the Cornplanter area. Modern wells drilled by rotary-drilling methods since 1950 permit the operator to take complete suites of wire-line electric logs that accurately determine many of the characteristics of the rock penetrated during drilling. A reasonably accurate picture of the regional subsurface stratigraphic framework (fig. 5) of the Cornplanter vicinity may be synthesized by correlating the lithology of well cuttings from the old deep cable-tool wells with suites of wire-line electric logs from adjacent more recent rotary-drilled wells. Although adequate for a generalized regional petroleum appraisal, these data are insufficient for making a detailed evaluation of the oil and gas potential of the Cornplanter Roadless Area. Consequently the evaluation must be more subjective because of the dearth of specific subsurface information.

Subsurface rocks—The Cornplanter Roadless Area is underlain by about 9,000 ft (2,745m) of Paleozoic sedimentary rocks from near surface Upper Devonian sandstone and shale to deeply buried Middle Cambrian sandy dolomite and arkosic sandstone (fig. 5).

Source rocks—Recent geochemical and geological studies have demonstrated that the main source rocks for oil and gas are fine-grained marine rocks that contain more than one percent organic carbon by weight. The process of thermal maturation, increasing temperature due to a progressively greater depth of burial of source rocks, converts part of the organic carbon to oil or gas or both depending upon the types of organic matter present in the source rocks. Most of the gray, greenish-gray, marine shales of the Upper and Middle Devonian and the Upper Ordovician (fig. 5) contain at least one percent organic carbon by weight and are lean source rocks. In contrast, the very dark gray, brownish-black, and black shales of the Upper Devonian Perrysburg, Java, West Falls, Sonyea, and Genesee Formations, and the Middle Devonian Marcellus Shale (Van Tyne and Peterson, 1978; Harper and Piotrowski, 1978; Schmoker, 1980) all contain several percent organic carbon and are therefore superior source rocks for oil and gas. Although data are not available for the Upper Ordovician Utica Shale in the study area, it also appears to have potential as a source rock.

The dark-brown to black fetid limestones in the Trenton and Black River Limestones contain considerable organic carbon and locally may be source rocks for both oil and gas. However much of these fluid hydrocarbons is widely dispersed in the relatively impermeable limestone and is not present in commercially recoverable amounts except under special conditions of extensive natural fracturing in strongly faulted and folded terranes.

Recent studies of the Devonian black shales rich in organic detritus show that the shales contain large volumes of gas absorbed on the organic matter. Under favorable circumstances of extensive natural fracturing the black shales may yield commercially exploitable volumes of gas. Although these so-called Devonian gas shales have not been productive in the few wells that penetrated the shale sequence near the study area, these wells were drilled before hydraulic fracture stimulation was adapted to stimulating the gas shales. Consequently the possibility that gas may be found in the gas-shale sequence in the study area should not be discounted. Also gas from the Devonian shales might be produced in conjunction with gas from deeper reservoirs under the study area if indications of gas are found in the Devonian shales in wells that are drilled to test the potential of older and more deeply buried rocks.

The presence of both oil and gas in the shallow Devonian sands of much of western Pennsylvania including the Cornplanter Roadless Area indicates that the abundant source rocks in the stratigraphic sequence have attained sufficient thermal maturity to generate oil and gas and to have released these hydrocarbons to adjacent reservoir rocks. A study of thermal maturation of Paleozoic source rocks of the Appalachian basin (Harris and others, 1978) demonstrated that the younger Devonian rocks of the Cornplanter area may contain oil and gas, whereas the older and more deeply buried Silurian, Ordovician, and Cambrian rocks will, most likely, contain only dry gas.

Reservoir rocks—Reservoir rocks are porous and permeable strata whose openings may contain oil or gas or both hydrocarbons in considerable quantities. The most common reservoir rock is porous and permeable sandstone. The 3,200 ft (1,100 m) of Upper Devonian rocks consist largely of siltstone, shale and mudrock, but contain 8-12 zones of lenticular sandstone intercalated in the upper 1,500-2,000 ft (457-610 m) of the sequence. Individual lenses of sandstone may be as much as 80 ft (24 m) thick and are the shallow Devonian sands of the well drillers (Lytle and Goth, 1970, p. 15-23). Most of the sands, which are identified by a variety of local names, lie in the Canadaway Group of Chadwick (1935); although a few of the youngest are in the lower part of the younger Conneaut Group (Lytle and Goth, 1970, pl. 9). Most of the oil and gas sands of the Canadaway Group are parts of a thicker and sandier sequence of rocks in the Bradford and associated oil and gas fields of central McKean County, Pa. This sequence thins to the west, and individual sands become thinner and decidedly more lenticular under the study area. Similarly the Warren sand (Lytle and Goth, 1970) and associated sands of the Conneaut Group are thicker and more continuous to the west and southwest of the study area in the vicinity of Warren and Oil City, Pa. Because the lenticular shallow Devonian sands under the Cornplanter area commonly grade laterally in relatively short distances into impermeable shale they cannot be correlated with certainty throughout the roadless area. Permeability and porosity of these reservoir sands vary abruptly. The sand lenses are stratigraphic traps which are considerably more difficult to locate than structural traps. Drilling is the only method for the positive confirmation of the presence or absence of stratigraphic traps in the

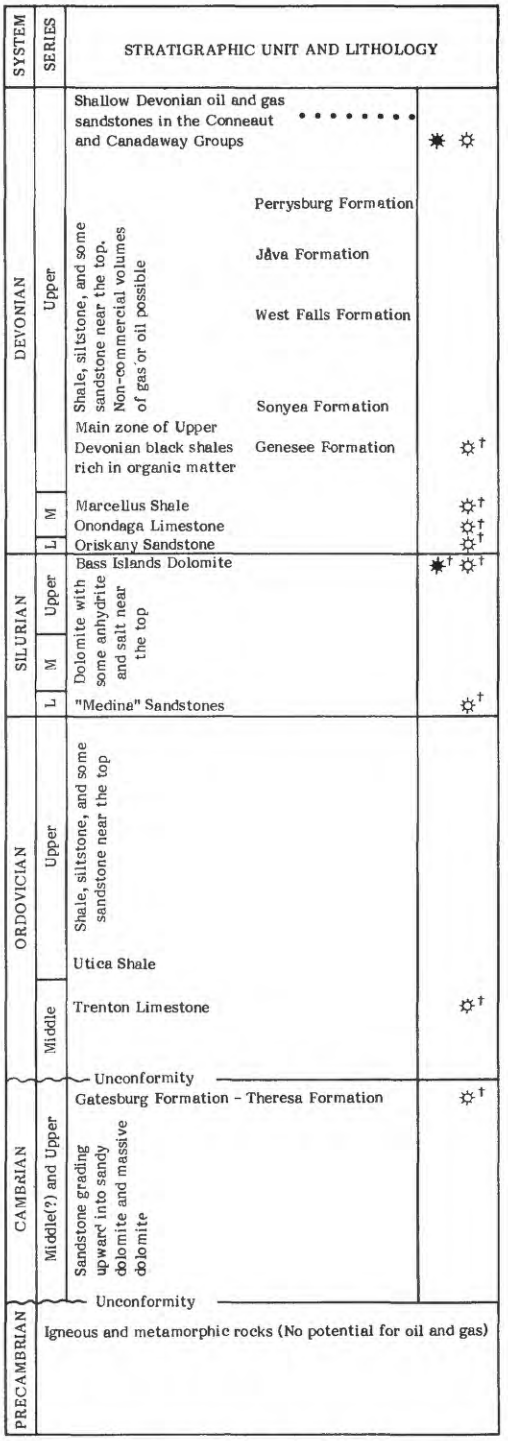

Figure 5.—Generalized lithologic section showing subsurface stratigraphic units mentioned in text.

shallow Devonian sands at any specific site in the study area.

For example, in the now abandoned Whisky Run field (fig. 4), which is located 0.8 mi (1.3 km) east of the southeast corner of the Cornplanter area, the five wells were spaced about 500 ft (153 m) apart in a field of about 16 acres (0.3 ha). The main producing sand, the shallow Devonian Cherry Grove, lies in the upper part of the Canadaway Group (Lytle and Goth, 1970, p. 37). However, gas was found in five other shallow Devonian sands in the field; yet none of the sands, excepting the Cherry Grove, was consistently productive in more than one well.

Most of the shallow Devonian wells, those drilled before 1955, were drilled with cable tools and if stimulated were shot by the explosion of liquid nitroglycerin in the well bore opposite one or more reservoir sand. Many of the finer-grained sands and the coarser-grained siltstones, particularly those of low permeability, did not respond favorably to being shot. Consequently, although the sands may have contained oil or gas, the wells could not be stimulated to commercial productivity and were abandoned as dry holes. Also during those times the low price paid for oil or gas made production from low-yield wells prohibitively expensive and led to the quick abandonment of such wells, particularly if they were located at some distance from a gathering line.

Since the introduction of hydraulic fracturing techniques for stimulating wells in the late 1950's, many low-permeability oil and gas sands, so-called tight formations, have been successfully stimulated to commercial productivity in wells that previously would have been abandoned as dry holes. The low-permeability parts of many shallow Devonian oil and gas sands respond well to stimulation by hydraulic fracturing by increased yield and by a longer period of productivity. Also the higher prices recently paid for both gas and oil have made many low-yield wells in tight sands commercially profitable to develop and produce. The combination of these factors has led to drilling new wells in old productive areas as well as to exploratory drilling in relatively untested areas. Considering the lenticularity of the shallow Devonian sands, the Cornplanter area contains a sufficient number of low-permeability sands in the vicinity of the old shallow-sand wells that show traces of gas or oil to merit considerable test drilling. In addition, considerable tracts in the study area have not been adequately tested by past drilling.

In the Middle Devonian sequence, the Marcellus Shale is a superior source-reservior rock combination that has produced gas for both commercial and domestic use to the north and east of the study area in Allegany, Schuyler, and Steuben Counties, N.Y. Locally the Onondaga Limestone has produced gas from reefs and sandy zones in the lower part of the formation in part of southern New York and adjacent Pennsylvania. Deep wells in the vicinity of the study area, however, did not find gas in the Onondaga Limestone, and the study area appears to lie outside the area of gas-productive Onondaga reefs in Pennsylvania.

The Oriskany Sandstone, one of the most widespread gas-producing sands in the Appalachian basin, is an important reservoir rock in New York, Pennsylvania, Ohio, West Virginia, Maryland, and Virginia. It is probably present under the study area, but its thickness may not be much greater than 10 ft (3 m) (Oliver and others, 1971). Both the Felmont Oil Corporation's #1 Collins (Lytle and Goth, 1970) and the Appalachian Development Corporation's #1 E. A. Williams (Fettke, 1961) found saltwater in abundance in the Oriskany in the vicinity of the Cornplanter area (fig. 4).

In general the Silurian carbonate rocks do not contain appreciable amounts of oil and gas; however, the Bass Islands Dolomite, the uppermost unit in the sequence, contains sulfide-rich sour gas in the Bootjack gas pool to the southeast in Elk County, Pa. (Lytle, 1974; Welsh and Behum, 1982) and both oil and gas in Gerry Township, Chautauqua County, N. Y. (Van Tyne, A. M., oral commun., 1982). These occurrences bracket the study area and suggest that the Bass Islands Dolomite may contain gas under the Cornplanter area. The Lower Silurian "Medina sandstones", the "Grimsby sandstone" in particular, are some of the most important reservoir rocks in the northern part of the central Appalachians. The "Medina sandstones" of western New York and contiguous Pennsylvania and southern Ontario and the Clinton sands of Ohio, their lateral equivalent, have produced gas since the early 1880's. Locally small amounts of oil accompanied gas from the "Medina sandstones" of Erie County, Pa., but the volume of oil decreased to the east, and the "Medina sandstones" of Chautauqua and Cattaraugus Counties, N. Y. and Warren County, Pa., yield only dry gas. The "Medina sandstones" of New York and northwestern Pennsylvania are low-permeability, tight reservoir rocks in which the occurrence of gas is in stratigraphic traps that are controlled by lateral variations in permeability and porosity within individual sandstone units. The "Medina sandstones" respond well to stimulation by hydraulic fracturing.

At present an active drilling campaign to explore for gas from the "Medina sandstones" is in progress in eastern Chautauqua and western Cattaraugus Counties, N. Y., and in adjacent parts of western and central Warren County, Pa., less than 20 mi west of the study area. The widespread nature of the "Medina sandstones", which accumulated as beaches, offshore bars, and offshore blanket sands, assures that they will be present under the Cornplanter area, and the production of commercially recoverable volumes of gas in the general vicinity suggests that the "Medina" has a moderate potential for gas under the study area.

The Trenton Limestone has produced gas from shallow wells to the northeast in north-central New York. Most of these Trenton gas wells were drilled many years ago, and little data are available as to their reservoir characteristics and production history. The Trenton and Black River Limestones have not been productive in the very few wells penetrating these rocks in the general vicinity of the Cornplanter Roadless Area, and most probably they can be dismissed as a potential producing zone beneath the study area.

The greater part of the Cambrian and Ordovician carbonate-rock sequence is of Middle and Late Cambrian age and consists largely of light- to dark-gray, fine- to coarsely-crystalline dolomite. Many beds of dolomite contain appreciable amounts of quartz sand, and locally sandstone predominates over dolomite, especially near the unconformity at the top of the Cambrian rocks and in the basal part of the sequence just above the Precambrian basement

complex of igneous and metamorphic rocks. Locally Ordovician erosion removed the soluble carbonate cement from beds of sandy dolomite and dolomitic sandstone associated with the unconformity at the top of the Cambrian sequence to form porous reservoir rocks. In extreme western Pennsylvania these porous beds contain both gas and saltwater. Data are insufficient to determine if similar porous zones are present under the study area.

The Cambrian rocks become more sandy with depth and grade downward into a zone of fine- to very coarse grained dolomitic arkosic sandstone about 100 ft (30 m) thick. The arkosic rocks rest unconformably on the Precambrian basement complex whose petroleum potential is essentially zero. Relatively little is known about the basal Cambrian arkosic sandstones in the vicinity of the study area. A few deep wells in western New York along the south shore of Lake Ontario penetrated the basal sandstone and encountered flows of saltwater that demonstrated the permeability and porosity of the sandstone about 100 mi north of the study area.

Very few deep wells have been drilled into the Cambrian and Ordovician rocks in the general vicinity of the Cornplanter Roadless Area; consequently the presence of extensive reservoir rocks in the sequence under the study area is largely conjectural. However, gas has been found in beds of sandstone in the upper part of the Cambrian sequence near Bradford, McKean County, Pa.; near Dunkirk, Chautauqua County, N, Y.; and in western Erie County, Pa. These findings bracket the study area and suggest that porous reservoir rocks containing gas and salt water may be present in the Cambrian rocks under the study area.

Oil and gas summary—The Cornplanter Roadless Area has a high potential for natural gas and a moderate potential for oil. Thick sequences of source rocks are present in several zones in the stratigraphic sequence under the study area. The level of thermal maturity is sufficiently high to have generated both oil and gas which have migrated into adjacent reservoir rocks. The presence of both oil and gas pools in the area shows that seals were effective in retaining fluid hydrocarbons in the reservoir rocks until their release by the drill. Scattered subsurface data suggests the presence of source rocks, reservoir rocks, traps, and seals deeper in the Silurian, Ordovician, and Cambrian rocks under the study area.

Because of the great lenticularity of the shallow Upper Devonian reservoir rocks and the absence of most specific subsurface data in the Cornplanter Roadless Area, exploratory drilling is the only satisfactory method for determining the presence, geometry, and hydrocarbon content of potential reservior rocks beneath the study area.

Salt

A sequence of Middle and Upper Silurian dolomite, anhydrite, halite,and shale about 1,300 ft (396 m) thick underlies the Devonian rocks of the study area. The halite (rock salt) occurs in beds as thick as 35 ft (11 m) in the upper medial part of the carbonate-rock sequence. The beds of salt are part of a regionally extensive sequence of evaporitic rocks that underlies large parts of the Appalachian and Michigan basins (Rickard, 1969) and have been exploited by solution and mechanical mining for industrial and domestic use at many places in both basins. Individual beds of salt are regionally extensive and have been identified in both basins by correlation of drill cores and wire-line geophysical logs. Beds of salt under the Cornplanter Roadless Area are too deeply buried and too thin to be recovered at present in competition with salt beds in the Silurian sequence at more favorably located sites to the north in central New York, or to the west, along the south shore of Lake Erie in the vicinity of Cleveland, Ohio.

Construction Materials

Shale, sandstone, conglomerate, and sand and gravel are potential construction materials found in the study area (fig. 6). About 20 mi to the west the Keystone Face Brick Company of Youngsville, Pa., used Devonian age Conewango Formation shales in red brick manufacturing (Leighton, 1941). Preliminary ceramic evaluations of five shale samples from the Conneaut Group of Chadwick from the study area indicate potential use in structural clay products (Welsh and Grau, 1982, p. 22). All shales tested were of suitable physical strength and working properties to be utilized as the raw material for building brick. One sample, PC-10, showed a very good firing range, and would be suitable for floor brick raw material. Because the preliminary bloating tests were all negative, none of the shales tested would be acceptable for lightweight aggregate.

Sandstone and conglomerate of Mississippian age are abundant in the study area. Potential uses for this material are limited to rough dimension stone as a consequence of impurities and the textural and bedding characteristics of the rock.

Sand and gravel were produced from a 0.5 acre (0.2 ha) pit in glacial outwash deposits near the Allegheny Reservoir, at the eastern boundary of the study area (fig. 6). The filling of Allegheny Reservoir flooded haul-road access to the pit and closed the operation. The material remaining in this pit, and other accumulations of sand and gravel along the eastern border of the study area, are of low resource potential because of the limited extent of deposits and poor access. An important constraint on the economic value of all potential construction materials found in the study area is the loss of haul-road access caused by the filling of Allegheny Reservoir.

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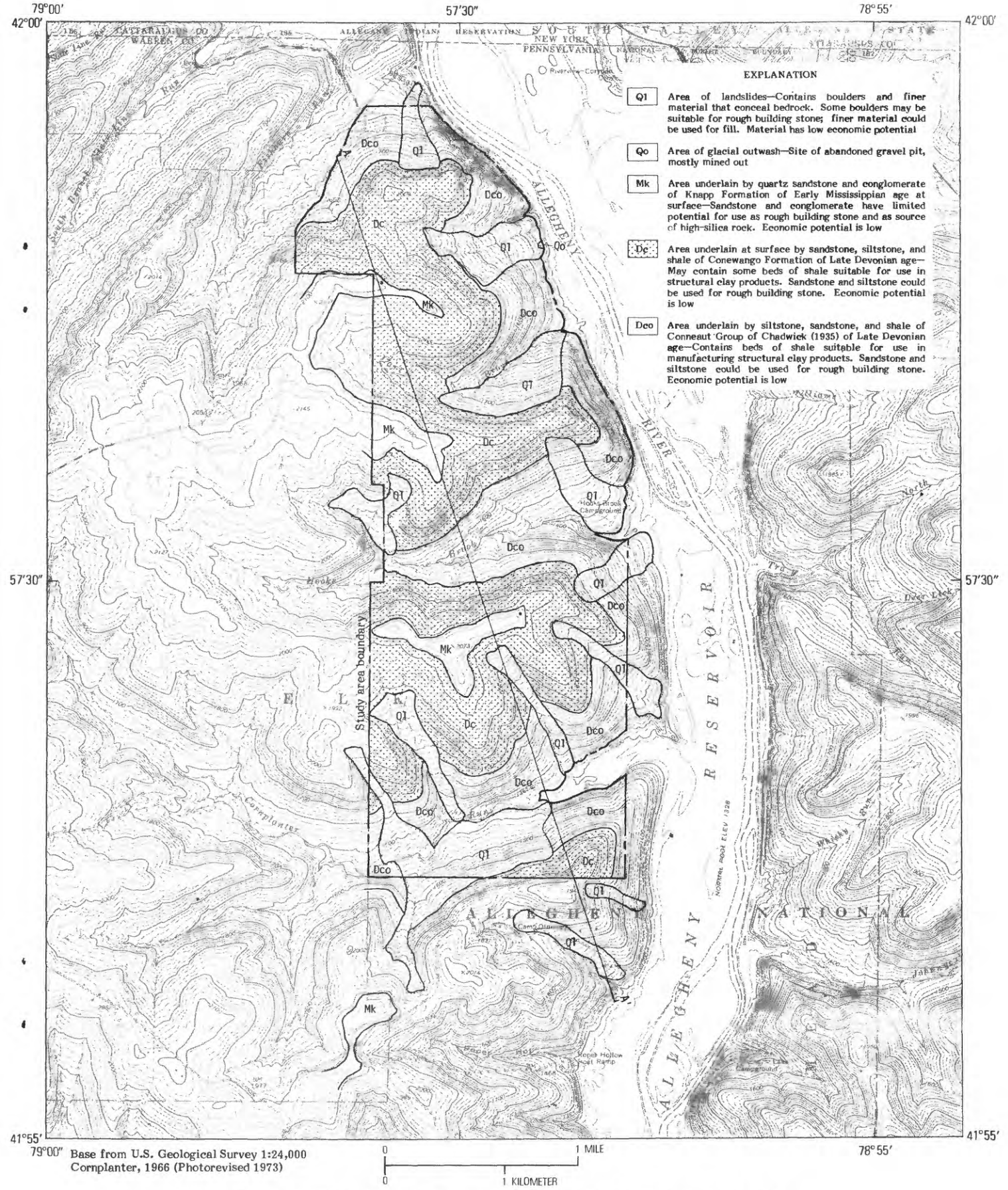

Figure 6.—Map showing nonfuel mineral resource potential of Cornplanter Roadless Area.

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