STUDIES RELATED TO WILDERNESS

WILDLIFE REFUGES

HURON, SENEY, MICHIGAN
SLANDS, MICH.; GREEN BAY
AND GRAVEL ISLAND, WIS.
and CHARONS GARDEN UNIT
WICHITA MOUNTAINS, OKLA.

GEOLOGICAL SURVEY BULLETIN 1260-I, J

Summary Report on the Geology and Mineral Resources of—

Huron, Seney, Michigan Islands Green Bay, and Gravel Island National Wildlife Refuges of Michigan and Wisconsin

By CARL E. DUTTON

Charons Garden Unit Wichita Mountains National Wildlife Refuge Comanche County, Oklahoma

By EDWARD L. JOHNSON

STUDIES RELATED TO WILDERNESS—WILDLIFE REFUGES

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A compilation of available geologic information

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STUDIES RELATED TO WILDERNESS

WILDLIFE REFUGES

The Wilderness Act (Public Law 88–577, Sept. 3, 1964) directs the Secretary of the Interior to review roadless areas of 5,000 contiguous acres or more, and every roadless island, within the national wildlife refuges and game ranges under his jurisdiction, and to report on the suitability or nonsuitability of each such area or island for preservation as wilderness. As one aspect of the suitability studies, existing published and unpublished data on the geology and the occurrence of minerals subject to leasing under the mineral leasing laws are assembled in brief reports on each area. These bulletins are two such reports and are two of a series by the U.S. Geological Survey and the U.S. Bureau of Mines on lands under the jurisdiction of the U.S. Department of the Interior.

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By CARL E. DUTTON

Summary

The Huron, Michigan Islands, and parts of the Seney, Green Bay, and Gravel Island National Wildlife Refuges in Michigan and Wisconsin are being considered for inclusion in the National Wilderness Preservation System. This report summarizes what is known of the geology and mineral resources of these refuge areas.

Surface materials of most of these areas are largely sand or gravel of Pleistocene or Recent age. Bedrock of the Huron Refuge is reported to be granite but that of the others is believed to be largely sedimentary rock of Paleozoic age. In all areas, bedrock types are those common in nearby areas; the bedrock is unlikely to be exploitable in or near the refuge areas.

There are no records of mineral production from the refuges or nearby areas and no known mineral deposits of commercial significance. The mineral-resource potential in all the areas is considered poor.

INTRODUCTION

The general location of the three wildlife refuges in Michigan and the two in Wisconsin is shown in figure 1. The Huron refuge is in the western part of the Upper Peninsula of Michigan, and the Seney refuge is in the eastern part. The Michigan Islands refuge comprises three islands—Pismire and Shoe Islands, in the northeastern part of Lake Michigan, and Scarecrow Island, near the center of the west shore of Lake Huron—that are geographically and geologically part of the Lower Peninsula. The Green Bay and Gravel Island refuges are near the end of the peninsular part of northeastern Wisconsin.

Sources of information concerning the designated refuges are scarce. Data for this report were obtained by examination of U.S. Geological Survey topographic quadrangle maps and of geologic maps and reports of Michigan and Wisconsin prepared by the respective State Geological Surveys. No published reports pertain directly to the refuges, and only one concerns the area adjacent to a refuge. No unpublished reports or other geologic information on the refuges or nearby areas is known, except a very general statement for one refuge. A field study of the refuges was not made.

The U.S. Bureau of Mines did not have occasion to make studies of the refuges because no minerals have been mined and because no deposits of commercial grade are known in the areas, but the Bureau of Mines has been informed of the findings of the U.S. Geological Survey and subscribes to the conclusions stated in this report.

GEOLOGIC SETTING

The surficial geology of the refuges is characterized by widespread and locally thick glacial deposits of Pleistocene age. Most of the material is glacial till, but glaciofluvial and lacustrine deposits of Pleistocene or Recent age are present, especially on islands and some mainland shore areas.

The surface materials rest upon bedrock that formed mainly in marine water during Paleozoic time and that is predominantly sandstone, shale, limestone, and dolomite in many different sequences. These sedimentary rocks were subsequently deformed into a basin about 400 miles in diameter; the center is in the Lower Peninsula of Michigan. This structure, called the Michigan basin, provides the bedrock setting of the refuges.

Erosion followed deformation, cut away the layers at the periphery of the basin, and produced a plainlike land surface. Truncation of the tilted layers also resulted in a concentric pattern of distribution in which younger rock formations form the

FIGURE 1.—Location of the Huron, Seney, Michigan Islands, Green Bay, and Gravel Island National Wildlife Refuges, Michigan and Wisconsin.

bedrock surface under the central part of the basin and progressively older formations are toward the periphery. Old formations of the sequence are at the surface in the Upper Peninsula of Michigan and in eastern Wisconsin. Four of the five refuges are on the northern flank of the Michigan basin. The Huron refuge lies beyond the northern edge of the Michigan basin. Islands of

this refuge are composed of granite and associated igneous dike rocks of Precambrian age, which, at least in part, are probably typical of those on which the Paleozoic succession rests.

NATIONAL WILDLIFE REFUGES

HURON

The Huron refuge is on the Huron Islands, which are 40 miles northwest of Marquette, Mich., and about 26 miles northeast of L'Anse at the head of Keweenawan Bay. The islands are in Marquette County and are shown in the northwest part of the Huron Mountains quadrangle and in the northeast part of the Skanee quadrangle of the U.S. Geological Survey 15-minute topographic map series. The islands are in T. 53 N., R. 29 W., about 2.6–4 miles north of the shore of Lake Superior, and form a group about 3 miles long and half a mile wide. Only 6 of the 31 islands in the group are more than 20 feet above the lake level and more than 400 feet long. Gull Island, the highest and largest, rises 161 feet above the lake and is about 0.8 mile long and 0.3 mile wide. Lighthouse Island is slightly smaller and lower. Two islands are not more than 1,000 feet long and 100 feet above the lake, and the remaining two islands are less than 500 feet long and 40 feet above the lake (fig. 2). Access to the islands is by boat or pontoon-equipped plane.

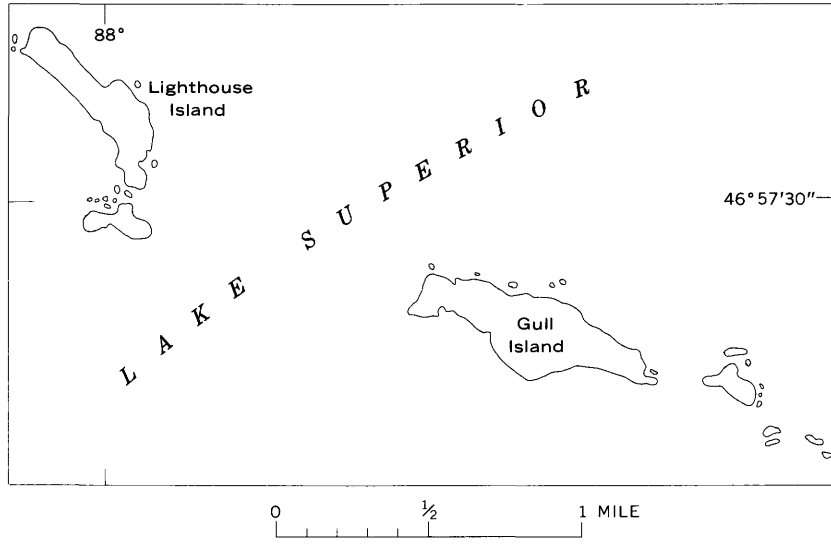

FIGURE 2.—Huron National Wildlife Refuge, Mich.

According to a note on the General Land Office plat (G.E. Eddy, State Geologist of Michigan, written commun., 1966), the Huron Islands "are summits of a range of hills which *** are granitic rocks, traversed by a large number of trap dikes running in various directions."

There are no known mineral deposits on islands of the refuge. The refuge has little possibility of containing mineral resources that are subject to leasing under the mineral leasing laws, as such resources commonly are not found in granitic rocks. There is no known reason to expect metallic mineral resources in rocks underlying the islands. As quarried construction material, the granitic rocks would not be competitive with similar rocks in more accessible nearby areas.

SENEY

The Seney National Wildlife Refuge is about 75 miles west of Sault Ste. Marie, Mich., and 20 miles north of Manistique, Mich.; the village of Seney is at its northeast corner (fig. 3). The refuge includes all or most of three townships (T. 44 N., R. 14 W.; T. 45 N., R. 14 W.; and T. 45 N., R. 15 W.) and relatively small parts of adjacent ones. The total area is approximately 150 square miles, of which a part about 4–4½ miles wide and 7½ miles long, near the western side is a candidate area for inclusion into the National Wilderness Preservation System. The candidate area contains approximately 19,150 acres and is mainly in the west half of T. 45 N., R. 15 W.

The Marquette and Sault Ste. Marie topographic quadrangle maps of the U.S. Geological Survey 1:250,000 series show that the Seney refuge is poorly drained and is part of the extensive Seney Marsh. The refuge is crossed by a few streams but is in general a slightly dissected surface that slopes gently and uniformly from an elevation of approximately 815 feet above sea level in the northwest part of the refuge to 675 feet in the southeast part.

The surface is mainly muck and peat on a sand plain that was formed during Pleistocene time by glacial outwash or lacustrine deposition or both. Potential mineral resources are not known in the surface materials, and none have been developed commercially in or near the refuge.

Bedrock is not exposed in the candidate area or elsewhere in the refuge, and the geology can be inferred only from data assem-

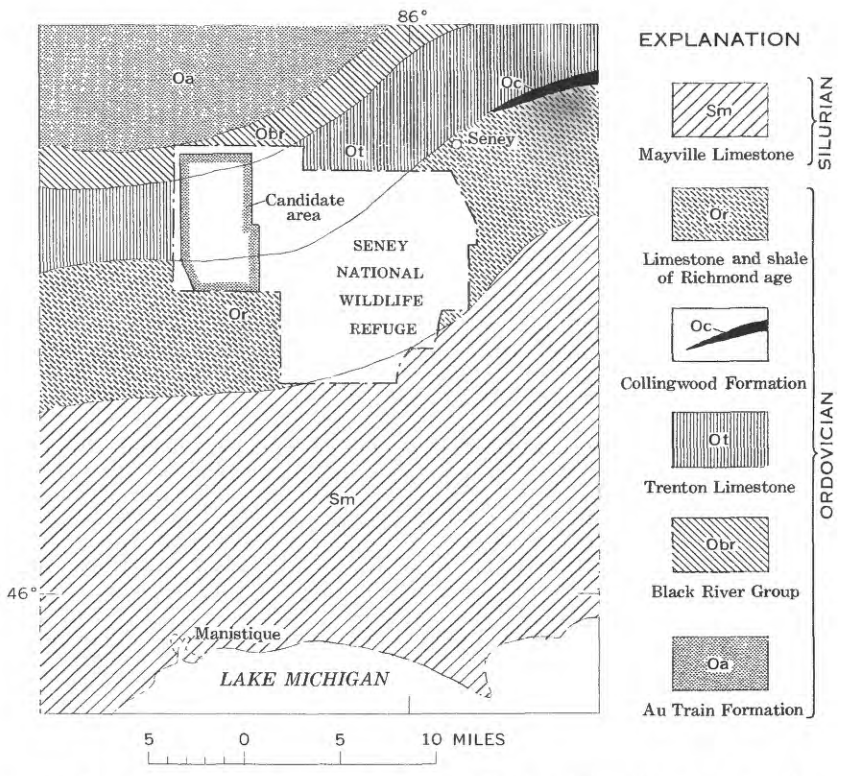

FIGURE 3.—Location and geology of Seney National Wildlife Refuge, Mich.

bled from the adjacent areas. The geologic map of the Upper Peninsula of Michigan (Martin, 1936) shows that the refuge is on the northwest flank of the Michigan basin and that it is underlain by a series of formations of Paleozoic age that trend generally northeast and dip southeast. Rocks of Cambrian age lie along the north edge of the peninsula and those of Silurian age lie along the south edge; the refuge is about midway between these rocks and is underlain by three formations of Ordovician age (fig. 3). Outcrops of Paleozoic formations in the eastern part of the peninsula are sparse and are mainly along or near the shores of Lake Superior and Lake Michigan.

Sedimentary rocks of Richmond age make up the youngest bedrock unit in the candidate area. It consists mostly of shale and some associated thin limestone beds, totaling 50 to about

300 feet in thickness. These rocks are not known to be utilized at present in the nearby region, and poor drainage in the refuge would probably preclude exploitation of them from the candidate area.

The Trenton Limestone underlies the rocks of Richmond age in the Seney refuge. It is made up of argillaceous limestone, thin dolomitic limestone, dolomite, and shale. The oldest Paleozoic strata beneath the refuge are the Black River Group, which includes limestone, argillaceous limestone, and minor sandy limestone. The combined thickness of the Trenton Limestone and the Black River Group is 100–270 feet. The Trenton Limestone was quarried about 50 miles west-southwest of the refuge (Martin and Straight, 1956) and was used locally for crushed stone and rough building stone. Limestone has not been quarried in the refuge, and poor drainage would make quarrying in the refuge inadvisable. The Black River Group and the Trenton Limestone extend south under the Lower Peninsula of Michigan. Where fractured and dolomitized, they serve as reservoirs from which petroleum and natural gas are produced. The possibilities of similar accumulations under the refuge or elsewhere in the Upper Peninsula are negligible because these formations are at the surface, and oil and gas that could have migrated up the dip of the strata would have escaped. Oil and gas usually accumulate in stratigraphic or structural traps, but such traps have not been discovered in the northern part of the Lower Peninsula or in the Upper Peninsula (Michigan Geological Survey Division, 1965).

The character of the Precambrian rocks beneath the refuge is not known, inasmuch as they are more than 1,000 feet below the surface.

There are no records of mineral production from the Seney refuge or nearby area. Bedrock in the candidate area is common sedimentary rock in which mineral resources of significance are not likely to occur.

MICHIGAN ISLANDS

Pismire Island

Pismire Island is about 35 miles west-southwest of St. Ignace (fig. 4) in Charlevoix County, Mich. It is about 0.65 mile from

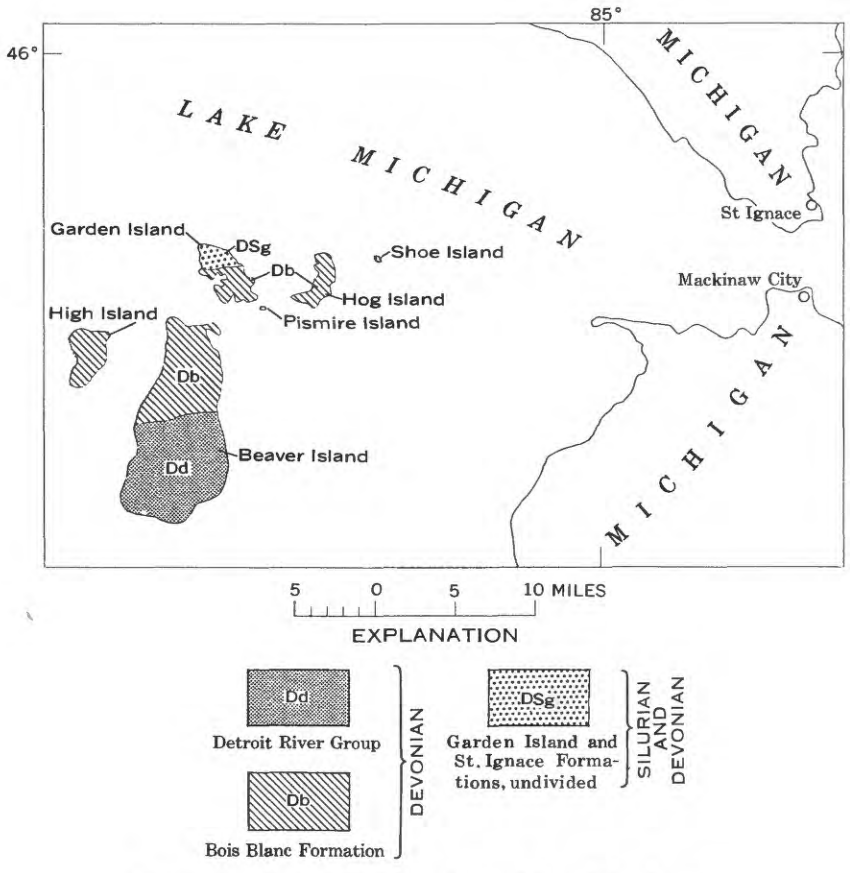

FIGURE 4.—Location of Pismire and Shoe Islands and geology of nearby islands, Michigan.

the southeast tip of Garden Island, as shown on the U.S. Geological Survey Hog Island topographic map. The island is an equilateral area approximately 500 feet long on each side. It is less than 10 feet above Lake Michigan and accessible only by boat or pontoon-equipped plane.

The geologic map of the Mackinac Straits area of Michigan (Landes and others, 1945) shows that the northern part of Garden Island is underlain by dolomites and shales of the St. Ignace Formation of Silurian age and by dolomite and dolomitic sandstone of the overlying Garden Island Formation of Devonian

age. The St. Ignace Formation is equivalent in age to part of the Salina Formation, which, in the mainland part of Michigan, contains salt and gypsum deposits. The southern part of Garden Island, the northern part of Beaver Island, and all Hog Island are shown as underlain by cherty limestones and dolomites of the Bois Blanc Formation of Devonian age. Presumably, this formation also underlies Pismire and Shoe Islands.

In the Pismire Island area the Bois Blanc Formation is underlain by about 2,000 feet of stratified rocks that are predominantly dolomite, limestone, and sandstone. No structures favorable for the accumulation of oil and gas are known in the area (Michigan Geological Survey Division, 1965). Two wells have been drilled to Precambrian basement rocks on nearby Beaver Island. One reached the basement at a depth of 4,705 feet below sea level; the other reached it about 700 feet higher (Cohee, 1965, p. 214). In neither well was there evidence of oil or gas.

No mineral commodities have been produced from Pismire Island or the nearby islands. Production of mineral commodities in nearby parts of Michigan, from strata equivalent to or older than the Bois Blanc Formation, is limited to a few quarry operations (Klyce, 1966). Limestone for flux in smelting iron ore is quarried about 25 miles northwest and 25 miles northeast of Pismire Island, but this limestone probably would underlie the island at a depth of at least 1,000 feet. Dolomite is quarried at localities about 55 and 85 miles east of the island for flux, road construction, and agricultural purposes, but the formation is at least 800 feet below the island.

Pismire Island is small, and access to it is difficult. Rocks that might crop out on it would not be expected to be of value for quarrying. The mineral-resource potential of the island is considered poor.

Shoe Island

Shoe Island is in Charlevoix County, about 28 miles west-southwest of St. Ignace, Mich., and 7 miles northeast of Pismire Island (fig. 4). It is 2.5 miles east-northeast of Hog Island, of which the nearest part is in sec. 1, T. 39 N., R. 9 W., and is accessible only by boat or pontoon-equipped plane. The island is about 100 feet wide and 500 feet long and rises less than 10 feet above Lake Michigan.

Shoe Island is believed to be formed by the same cherty limestone and dolomite that underlie nearby Hog Island, although the surface may be covered by sand of Recent age. These rocks in turn probably are underlain by the same stratigraphic sequence of rocks that underlies nearby Pismire Island.

There is no record of mineral production from Shoe Island or from the nearby islands. Structures favorable to the accumu-

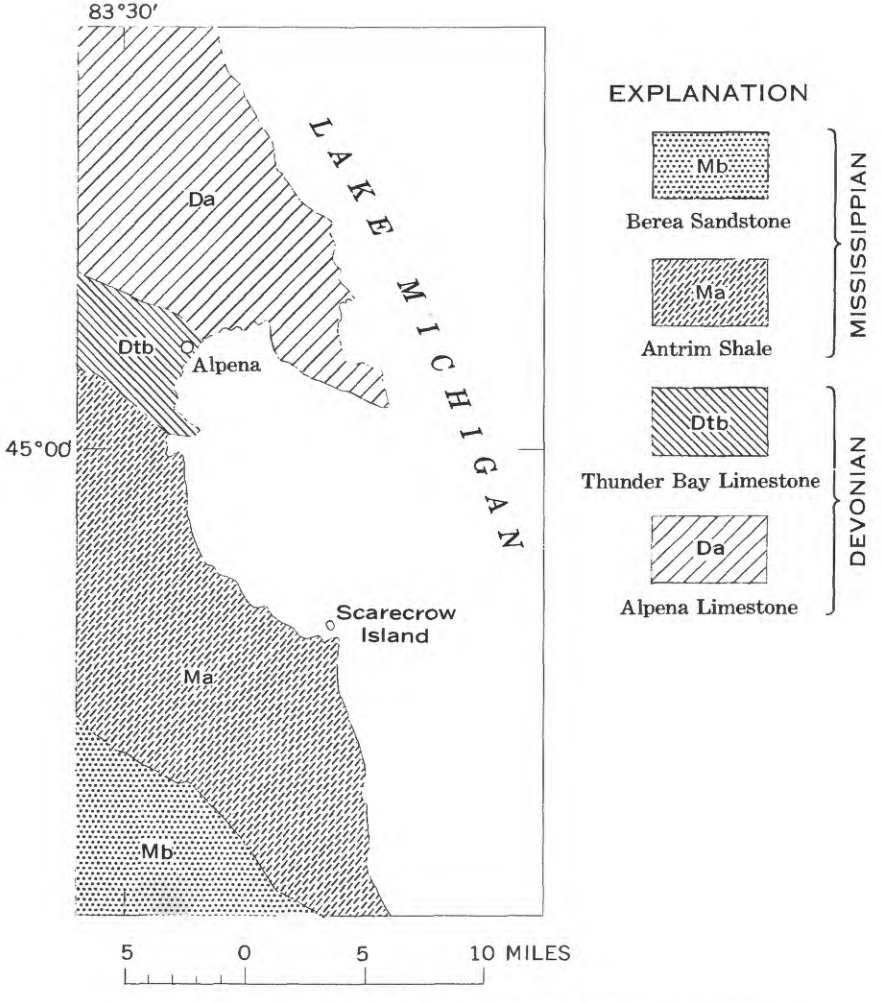

FIGURE 5.—Location of Scarecrow Island and geology of nearby mainland part of Michigan.

lation of oil and gas are not known in the area. The size and location of the island, the type of rocks that crop out on it, and the absence of known mineral deposits indicate that the island is of insignificant value from a mineral-resource-potential standpoint.

Scarecrow Island

Scarecrow Island is 13 miles south-southeast of Alpena (fig. 5) in the southeast part of Alpena County, Mich., in the southern part of Thunder Bay, about 2 miles east of the nearest mainland part of the county. The island is shown on the U.S. Geological Survey Tawas City quadrangle of the 1:250,000 series. It is about 1,500 feet long and 750 feet wide and rises less than 50 feet above Lake Michigan. It is accessible only by boat or pontoon-equipped plane.

The adjacent mainland and Scarecrow Island are on the northeast flank of the Michigan basin and are underlain by the Antrim Shale of Late Devonian and Mississippian age, although Recent sand probably covers the surface of Scarecrow Island.

The Antrim Shale and underlying Alpena Limestone are used for the manufacture of cement near Alpena (Klyce, 1966), but no other mineral production is known from the area. About 4,000 feet of Paleozoic rocks, mainly limestone and dolomite, underlies the Antrim Shale; some of these formations in other parts of Michigan contain petroleum and gas, but the closest production is 40 miles west of the island (Michigan Geological Survey Division, 1965). No structures favorable for the accumulation of oil or gas are known at or near the island. A well drilled in 1964 to a depth of 6,370 feet, in sec. 5, T. 31 N., R. 9 E., Alpena County, tested all potential oil and gas zones but reported no showings of gas or oil. No other wells drilled in Alpena County have found oil and gas in commercial quantities.

There is no record of mineral production from Scarecrow Island. The island is small, is relatively inaccessible, and is considered to have a low mineral-resource potential.

GREEN BAY

The Green Bay National Wildlife Refuge is on Hog Island, Door County, Wis. Hog Island is 0.6 mile east of Washington Island (fig. 6), which is near the mouth of Green Bay, Lake Michigan. Location of the island is shown on the U.S. Geological Survey Washington Island 15-minute topographic map. The island is about

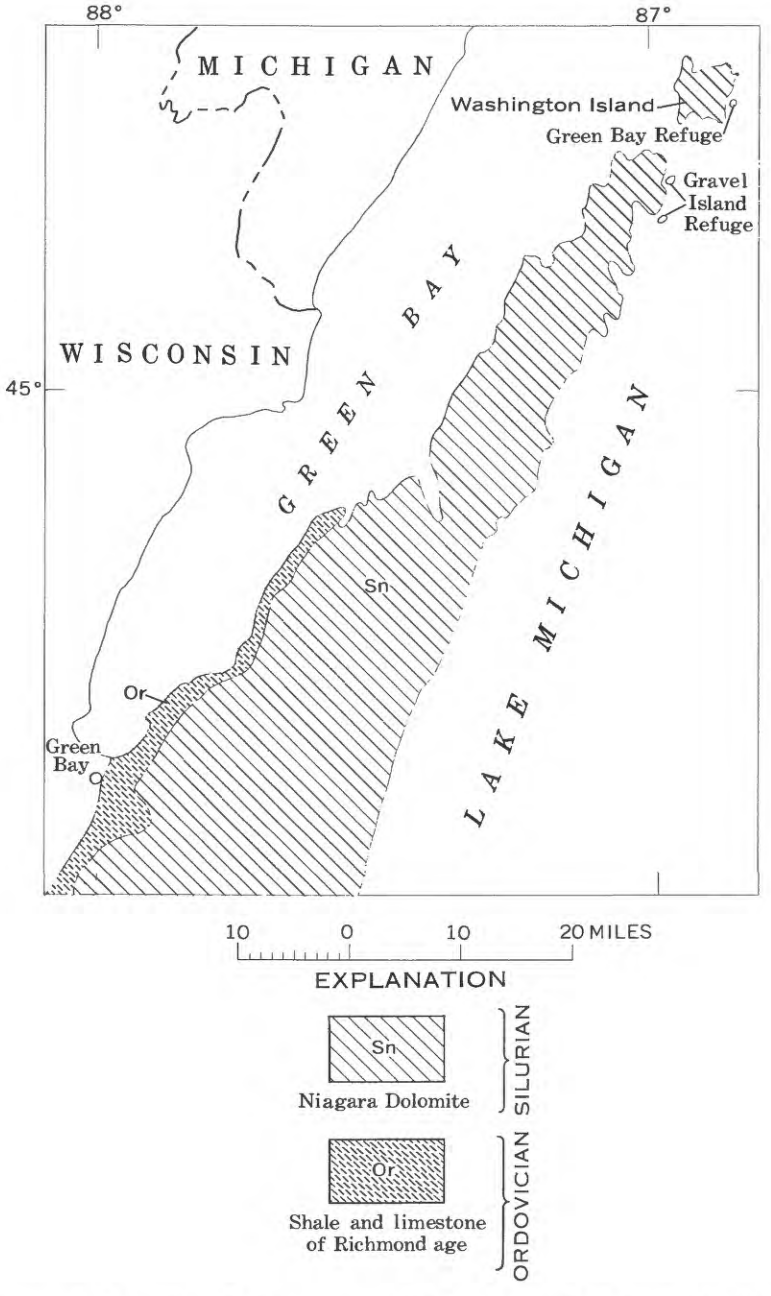

FIGURE 6.—Location of Green Bay and Gravel Island National Wildlife Refuges and geology of nearby Door Peninsula, Wis.

300 feet long and 200 feet wide, is less than 20 feet above Lake Michigan, and is accessible only by boat or pontoon-equipped plane.

The Niagara Dolomite of Silurian age underlies adjacent Washington Island (Bean, 1949) and also is believed to underlie Hog Island. The dolomite is underlain by about 1,200 feet of Ordovician and Cambrian rocks that are predominantly dolomite and sandstone. No mineral deposits are known in the areas where these rocks crop out in nearby parts of Wisconsin. The Niagara Dolomite has not been used industrially in Wisconsin. Hog Island is on the northwest flank of the Michigan basin, but no structures favorable for the accumulation of oil or gas are known in the vicinity of the island.

There is no record of mineral production from Hog Island, Washington Island, or the nearby mainland area. The small size of Hog Island and the fact that no mineral deposits are known in the rocks that underlie it indicate that the refuge has a poor potential for mineral resources.

GRAVEL ISLAND

The Gravel Island National Wildlife Refuge includes Gravel and Spider Islands (fig. 6), Door County, Wis. Gravel and Spider Islands are 9 and 12 miles, respectively, southwest of the Green Bay refuge, just off the eastern tip of Door Peninsula. Gravel Island is shown on the Washington Island topographic map of the U.S. Geological Survey 15-minute series, and Spider Island is shown on the Sister Bay topographic map of the same series. Gravel Island is about 300 feet long and 150 feet wide and is less than 20 feet above Lake Michigan; Spider Island is about 2,200 feet long, from 300 to 700 feet wide, and less than 20 feet above the lake. Access to either island is only by boat or pontoon-equipped plane.

The Niagara Dolomite of Silurian age underlies the Door Peninsula (Bean, 1949) and also is believed to underlie both Gravel and Spider Islands. No mineral deposits are known in this dolomite on the nearby Door Peninsula, nor is there any record of production from underlying rocks of that area. No oil or gas has been produced in Wisconsin.

There is no record of mineral production on either Gravel or Spider Islands. The geologic setting and small size of these islands

indicate that their potential for significant mineral resources is poor.

CONCLUSIONS

None of the candidate wilderness areas considered in this report has any recorded mineral production. None contains any known mineral deposits of commercial significance. None contains geologic structures that indicate that mineral deposits subject to the mineral leasing laws might underlie the areas. The mineral-resource potential in all the areas is considered poor.

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Summary Report on the Geology and Mineral Resources of the Charons Gardens Unit Wichita Mountains National Wildlife Refuge, Comanche County, Oklahoma

By EDWARD L. JOHNSON

STUDIES RELATED TO WILDERNESS—WILDLIFE REFUGES

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SUMMARY REPORT ON THE GEOLOGY AND MINERAL RESOURCES OF THE CHARONS GARDEN UNIT WICHITA MOUNTAINS NATIONAL WILDLIFE REFUGE, COMANCHE COUNTY, OKLAHOMA

By EDWARD L. JOHNSON

Summary

The Charons Garden Unit, an area of about 5,000 acres in the Wichita Mountains National Wildlife Refuge, Comanche County, southwestern Oklahoma, is being considered for inclusion in the National Wilderness Preservation System. The candidate area is near the center of the Wichita Mountains and almost everywhere is underlain by granite. No deposits of minerals subject to the mineral leasing laws are known in the candidate area. Inasmuch as such minerals are found normally in sedimentary rocks and as the proposed wilderness area is underlain by igneous rocks, the presence of commercial deposits of these minerals in the area is extremely unlikely.

There is no record of mineral production from the candidate area, and there are no known deposits of metallic minerals. Insignificant deposits of copper, lead, silver, and titaniferous magnetite occur in the Wichita Mountains, although none are known in the candidate area. Granite has been quarried near the refuge. Granite suitable for monumental and building stone undoubtedly can be found in the proposed wilderness area, but granite is widely available and more accessible in areas outside the refuge.

INTRODUCTION

This study summarizes what is known of the geology and mineral resources of the Charons Garden Unit, Wichita Mountains National Wildlife Refuge, which has been proposed for inclusion in the National Wilderness Preservation System. The study was based on an office review of available information.

The U.S. Bureau of Mines did not have occasion to study the refuge because of the absence of mineral production or mineral

deposits. The Bureau has been informed of the findings of the U.S. Geological Survey, however, and concurs in them.

LOCATION

The Wichita Mountains National Wildlife Refuge in Comanche County, southwestern Oklahoma (fig. 1), is near the center of the Wichita Mountains, adjacent to and northwest of the Fort Sill Military Reservation. The Charons Garden Unit is in the southwest part of the refuge, about 18 airline miles west-northwest of Lawton. The unit has an east-west length of 4 miles and a north-south width of a little over 3 miles and contains about 5,000 acres in the eastern part of T. 3 N., R. 15 W., and in the western part of T. 3 N., R. 14 W., Indian meridian.

TOPOGRAPHY

The Wichita Mountains rise abruptly above the broad gently rolling plains of southwestern Oklahoma. The hills of the candidate area generally have rugged slopes and sparse vegetation.

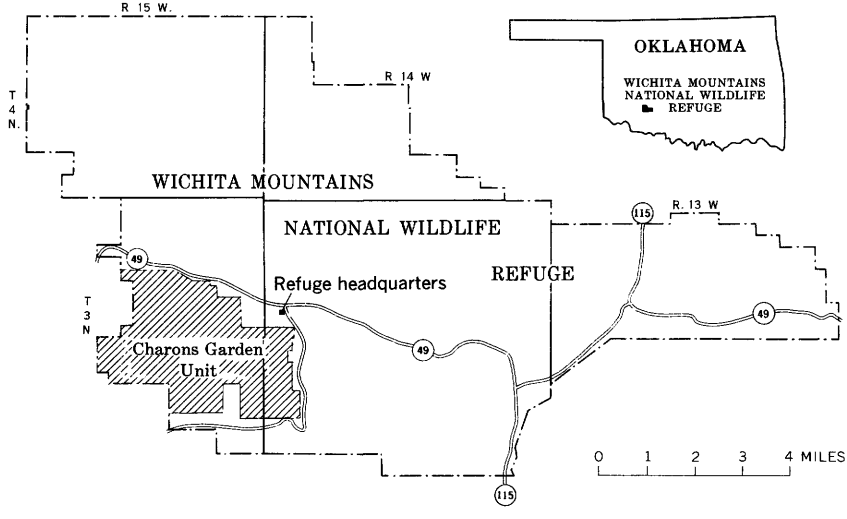

FIGURE 1.—Index map of Wichita Mountains National Wildlife Refuge, Comanche County, Okla.

Talus covering parts of hills is composed mostly of cobbles and boulders which range in size from a few inches in maximum dimension to large rounded or semirounded masses of rock as much as 100 feet long and 50 feet high (Hoffman, 1930, p. 10). Most of the soil and vegetation is in the narrow valleys that are between rocky and roughly rounded ridges and peaks.

The highest point in the candidate area is Elk Mountain, which is shown to be approximately 2,280 feet above sea level on the Quanah Mountain topographic quadrangle map of the U.S. Geological Survey; the lowest point is in the southwestern corner of the area near the Indiahoma road, where the elevation is shown on the Odetta topographic quadrangle map to be approximately 1,440 feet.

ACCESS

The Charons Garden Unit can be reached by going west from Lawton on U.S. Highway 62 and Oklahoma State Highway 7 to Cache, Okla.; then north on Oklahoma State Highway 115 to a junction with Oklahoma State Highway 49; then west on Oklahoma State Highway 49 to a junction with a refuge road near the refuge headquarters. From the junction near the headquarters, Oklahoma State Highway 49 continues west roughly parallel to the northern boundary of the candidate area; another road goes south and more or less parallels the eastern and southern boundaries of the candidate area. All these roads are paved.

ACKNOWLEDGMENTS

The writer wishes to acknowledge the cooperation and assitance of Mr. Julian A. Howard, Manager of the Wichita Mountains National Wildlife Refuge, U.S. Bureau of Sport Fisheries and Wildlife; Mr. R. S. Sanford, Area Director, and his staff of the U.S. Bureau of Mines; and Dr. Carl C. Branson of the Oklahoma Geological Survey.

GEOLOGY

GEOLOGIC SETTING

The Wichita Mountains consist of uplifted igneous rocks of Cambrian(?) age (Ham and others, 1964) surrounded by sedi-

mentary rocks of Permian age. The candidate area is underlain mostly by granite (Ham and others, 1964, p. 67) and a few very small areas of Permian conglomerate (Miser, 1954). The granite contains numerous faults and joints with the most prominent faults trending west-northwest nearly parallel to the mountains; minor faults and joints trend in many directions.

The stratigraphic nomenclature used in this report follows that of the Oklahoma Geological Survey and does not necessarily follow that of the U.S. Geological Survey.

Cambrian(?) Rocks

Rocks of the Wichita Mountains have been classified into five basement-rock groups (Ham and others, 1964). Two of the rock groups crop out in or near the proposed wilderness area.

Raggedy Mountain Gabbro Group.—The oldest rocks in the area are part of a stratiform body of basic igneous rocks called the Raggedy Mountain Gabbro Group. These rocks are chiefly diallage gabbro, anorthosite, olivine gabbro, troctolite, and quartz diorite and are considered by Ham and others (1964, p. 91) to be of Early Cambrian(?) age.

Rocks of the Raggedy Mountain Gabbro Group are not exposed in the candidate area. The nearest outcrop is about 1 mile north of the refuge headquarters (Hoffman, 1930, p. 37; Ham and others, 1964, p. 93). It is believed, however, that rocks of the group are near the surface in the northern part of the candidate area.

Wichita Granite Group.—The Wichita Granite Group (Ham and others, 1964, p. 60) consists of several types of pink medium-grained granitic rock, which differ noticeably in texture, somewhat in mineral composition, and slightly in age. These are the most widely exposed rocks in the Wichita Mountains, and they crop out over an area about 65 miles long and 25 miles wide. The granites occur as intrusive plutons and sills in and above rocks of the Raggedy Mountain Gabbro Group and in the lower parts of rhyolite flows. Rocks of the Wichita Granite Group are considered by Ham and others (1964, p. 60) to be Middle Cambrian(?) in age. Nearly all the Charons Garden Unit is underlain by rocks of the Wichita Granite Group.

Permian Rocks

The geologic map of Oklahoma (Miser, 1954) shows very small areas of Permian sedimentary rocks along the northern and east-

ern boundaries of the candidate area. These rocks are considered to belong to the Post Oak Conglomerate Member, Wichita Formation, which was described and named by Chase (1954) and which generally overlies the igneous rocks in the Wichita Mountains and wedges out against the slopes of the hills. The conglomerate consists chiefly of granite cobbles and boulders interbedded with irregular crossbedded lenses of arkose.

STRUCTURE

The Charons Garden Unit is near the center of the Wichita uplift, an upthrown fault block or horst bounded on the northeast and southwest sides by high-angle normal faults (Ham and others, 1964, p. 157 and pls. 1 and 4). The granite in the candidate area is moderately to intensely faulted and jointed. Prominent faults in the area and a major joint system have a west-northwest trend, and other less prominent faults and joints have north-northwest, north-northeast, and northeast trends. Most of the faults and joints are nearly vertical. Displacement of the faults generally cannot be measured, but Hoffman (1930, p. 16) indicates that movement along the fault planes in the candidate area probably was small. The faults may be traced easily on aerial photographs because their trends are marked by generally long, very narrow, nearly straight steep-walled valleys where soil, trees, and other vegetation are concentrated.

MINERAL RESOURCES

The candidate area in the Wichita Mountains National Wildlife Refuge is public domain that has been withdrawn from entry for the purpose of the location of mining claims. Consequently, primary consideration was given to minerals subject to leasing under the mineral leasing laws and to mineral commodities used for construction purposes. No mineral deposits are known to occur in the proposed wilderness. The only mineral industry in the vicinity of the proposed wilderness area is a granite quarry.

The nearest oil and gas production is from the Lawton field about 22 miles southeast of the candidate area. Wells in this field yield small amounts of oil and gas from rocks of Permian age that are found at shallow depths. All exploratory wells drilled in Permian rocks within a few miles of the candidate area, however, have been dry (Rinehart's Oil Reports, 1949–66). These wells indicate that a relatively thin section of sedimentary rocks covers the basement rocks near the refuge; these findings would discourage further drilling in that area.

NONMETALLIC MINERALS

The leasable minerals—asphalt and bituminous sand, coal, oil and gas, and oil shale—are found in sedimentary rocks, and because almost the entire proposed wilderness area is underlain by granite, the possibility of finding any of the above minerals would be extremely remote.

Other leasable minerals—phosphate, potash, and sodium compounds—are also found principally in sedimentary rocks. Chemical analyses of granite from the vicinity of the proposed wilderness area show that these rocks contain only the amounts of phosphorus, potassium, and sodium normal for igneous rocks and far below the content necessary for commercial development (U.S. Bureau of Mines, 1960, p. 655–658).

CONSTRUCTION MATERIALS

Granite is the principal mineral commodity produced in the vicinity of the refuge. A granite quarry, about half a mile northwest of the proposed wilderness area, operates intermittently and produces material for monuments and building stone (Warren, 1955; Oklahoma Geological Survey, 1944).

The proposed wilderness area is underlain almost entirely by granite, much of which might be suitable for quarrying. More accessible granite is outside the refuge area and in such extensive amounts that it can fulfill any foreseeable need for quarried material.

METALLIC MINERALS

The Wichita Mountains were thoroughly prospected for metallic minerals during the late 1890's and early 1900's. Woodruff (1904, p. 23) estimates that perhaps 2,500 claims were staked in the region and that hundreds of short exploratory workings were driven but that no significant mineral occurrences were found. Bain (1904, p. 120) investigated reported occurrences of gold in the Wichita Mountains but did not find any in the samples he collected. It was his belief that properties he examined did not warrant additional prospecting. Rare and insignificant amounts of copper, lead, and silver were reported by Bain (1904, p. 122). Claim staking in most of the refuge area ceased in 1905, when the area was incorporated in the Wichita Forest Reserve. Little prospecting is believed to have been done in the area since then. There are no mining claims in the candidate area at the present time (1967). The area is closed to mineral exploitation, and prospecting is prohibited.

Deposits of titaniferous magnetite are found in the Wichita Mountains in gabbroic rocks and recent alluvial sands (Chase, 1951, p. 11; 1952, p. 6), but none of these is of significant value for either iron or titanium. The absence of gabbro outcrops or alluvial sands within the proposed wilderness area makes the finding of titaniferous magnetite deposits unlikely.

CONCLUSIONS

The mineral potential of the Charons Garden Unit of the Wichita Mountains National Wildlife Refuge is considered to be very low. There is little likelihood of finding minerals subject to the mineral leasing laws in the igneous rocks that underlie most of the area. Significant deposits of metallic minerals have not been found in or near the area, and prospecting for them within the refuge is prohibited.

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