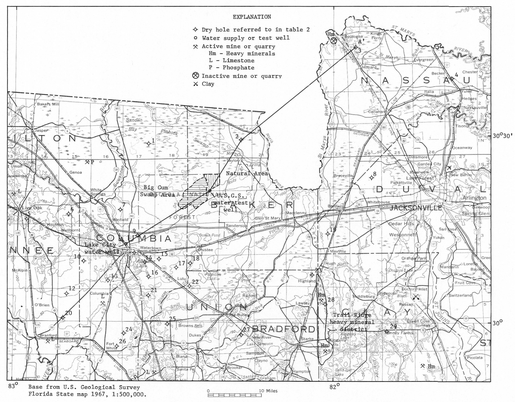
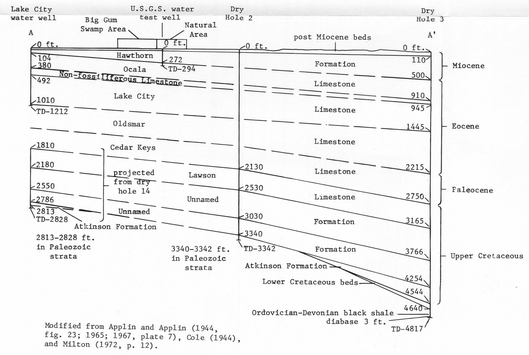




Modified from Applin and Applin (1944, fig. 23; 1965; 1967, plate 7), Cole (1944), and Milton (1972, p. 12).

Figure 1.—Location of the Big Gum Swamp and Natural Area Roadless Areas and dry holes, pits, mines, and quarries.

Index map showing location of the Big Gum Swamp Roadless Area

Studies Related To Wilderness

The Wilderness Act (Public Law 88-577, September 3, 1964) and related acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas on Federal lands to determine the mineral resource potential. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the Big Gum Swamp Roadless Area (08-010), Osceola National Forest, Columbia and Baker Counties, Florida. The Area was classified as a proposed wilderness during the Second Roadless Area Review and Evaluation (RARE II) by the Forest Service, January, 1979, and established as a wilderness by the Florida Wilderness Act of 1984 (Public Law 98-430, September 28, 1984).

SUMMARY

The Big Gum Swamp Roadless Area, which is in the Osceola National Forest in Columbia and Baker Counties, Florida, (Index map) is underlain by sedimentary rocks containing phosphate deposits that are not economic by todays standards. The region has a low potential for oil and gas, and virtually no potential for other valuable minerals. The phosphate deposits are either slightly low in tonnage and P_2O_5 content, high in MgO, Fe_2O_3 + Al_2O_3, or the ratio of CaO to P_2O_5 is too high for deposits that can be mined profitably at the present time. A low potential for oil and gas is indicated by the numerous dry holes in the region and the absence of the formations that contain these hydrocarbons in southern and westernmost Florida. The only mineral material that has been produced in the Big Gum Swamp area is clayey sand, used in stabilizing Forest Service roads. This type of clayey sand has no particular value because there are virtually unlimited quantities in the surrounding region. The peat in the area is too thin to be mined. Large quantities of limestone underlie the area but are too deeply buried to be quarried. Heavy mineral and clay deposits, which are mined elsewhere in northern peninsular Florida, are not present in the area.

INTRODUCTION

The Big Gum Swamp Roadless Area (figs. 1 and 2) comprises 13,600 acres in the north-central part of the Osceola National Forest in Columbia and Baker Counties, about 12 airline miles northeast of Lake City, Fla. The area is bounded by Forest Service road 211 and Florida highway 250 on the south, Forest Service roads 233 and 232 on the west and north, and Forest Service road 235 on the east. The area can be reached by traveling 11.7 mi on Florida Highway 250 northeast from its junction with U.S. Highway 441, north of Lake City to the junction of Highway 250 and Forest Service road 233, thence north 1.3 mi on the Forest Service road to the southern corner of the area.

The geology of the Big Gum Swamp Roadless Area, which is discussed briefly in this report, is covered in somewhat more detail in a report by Patterson, Cathcart, Cameron, and Schruben (1984). The mineral resource potential is quite similar to that in the Natural Area Roadless Area outlined by Cathcart, Patterson and Crandall (1983). The Natural Area, which is east of the eastern boundary of the Big Gum Swamp (fig. 1), also was designated a Wilderness Study Area by Public Law 98-430, September 28, 1984.

Previous Investigations

A report by Miller (1978) outlines the geology of the region as related to water resources and includes the geologic information in this report is taken from his work. A lengthy environmental impact statement (U.S. Bureau of Land Managment, 1974) contains much information on the entire Osceola National Forest and the effect of possible phosphate mining. Reports by Puri and Vernon (1964), Milton (1972), Bridge and Berdan (1952), Applin (1951), Applin and Applin (1944, 1965, 1967), Cole (1944), and Rainwater (1971) outline the subsurface geology of the region. Available information on the mineral resources in northern Florida include the following references: limestone (Schmidt and others, 1979), phosphate (Cathcart, 1968; Mansfield, 1942; Sever, Cathcart, and Patterson, 1967), and heavy minerals (Garner, 1972, 1981; Pirkle and Yoho, 1970; Pirkle, Pirkle, and Yoho, 1977).

Present Investigation

Cathcart and Patterson reviewed the published information on the geology of the Osceola National Forest region and reconnoitered the area in the early spring of 1980. A drilling program was carried out jointly with the U.S. Bureau of Mines in October 1980. During this program two holes were drilled near the boundaries of Big Gum Swamp (fig. 2, holes 1 and 2) and one hole was drilled along the south boundary of the adjoining Natural Area Roadless Area (fig. 3, hole 3). Core and cuttings were logged at the drill hole sites and samples were collected for later analyses in the laboratory. Cornelia C. Cameron, assisted by Paul C. Schruben, investigated both areas for peat resources (defined as organic material having an ash content not exceeding 25 percent on a dry-weight basis and 4 ft or more in thickness) in December 1980.

Information on oil and gas exploration holes in this report is based primarily on published reports and records on file in the Florida Bureau of Geology. "The term "dry hole" means that no significant amounts of oil and gas were found.

No geochemical survey was necessary during the work leading to this report because any potentially valuable non-metallic minerals are deeply buried. Therefore, stream-sediment and soil sampling would yield no information of value in assessing the mineral resource potential of the area. Metallic and other heavy mineral deposits of economic grade do not occur in sufficient concentrations to form valuable mineral deposits.

Acknowledgments

The authors are grateful for the cooperation of the Florida Bureau of Geology, the U.S. Forest Service, and the U.S. Bureau of Land Management. Thomas M. Scott, geologist with the Florida Bureau, worked with Patterson during the drilling program and assisted in logging core and interpreting lithologies. David Curry and Felipe A. Pontigo, Jr., of the same Bureau, aided in gathering information on oil and gas. R.J. Bonyata, District Ranger of the Osceola National Forest, provided maps and storage facilities for drilling equipment and samples. William R. Waite, soil scientist, U.S. Forest Service Office, Tallahassee, Fla., and Edward W. Bond, geologist, U.S. Forest Service Office, Atlanta, Ga., provided maps and background information on the region. Walter T. Lewieki of the U.S. Mineral Management Service provided the nonproprietary phosphate-drilling records of the Osceola National Forest.

SURFACE- AND MINERAL-RIGHTS OWNERSHIP

The Federal Government owns all surface and mineral rights in the Big Gum Swamp Roadless Area. They were acquired under the authority of the Weeks Act in the 1930's by the U.S. Department of Agriculture, Forest Service.

GEOLOGY

All of the Big Gum Swamp Roadless Area is blanketed by unconsolidated sediments of Pleistocene and Holocene age (fig. 2). The sediments in swamps consist of peaty material and organic-rich muck (Avers and Bracey, 1973). The A-horizon soils, rarely more than 1 ft thick, cover the dryer areas and consist of clayey and sandy material containing minor amounts of disseminated organic matter and roots and remains.

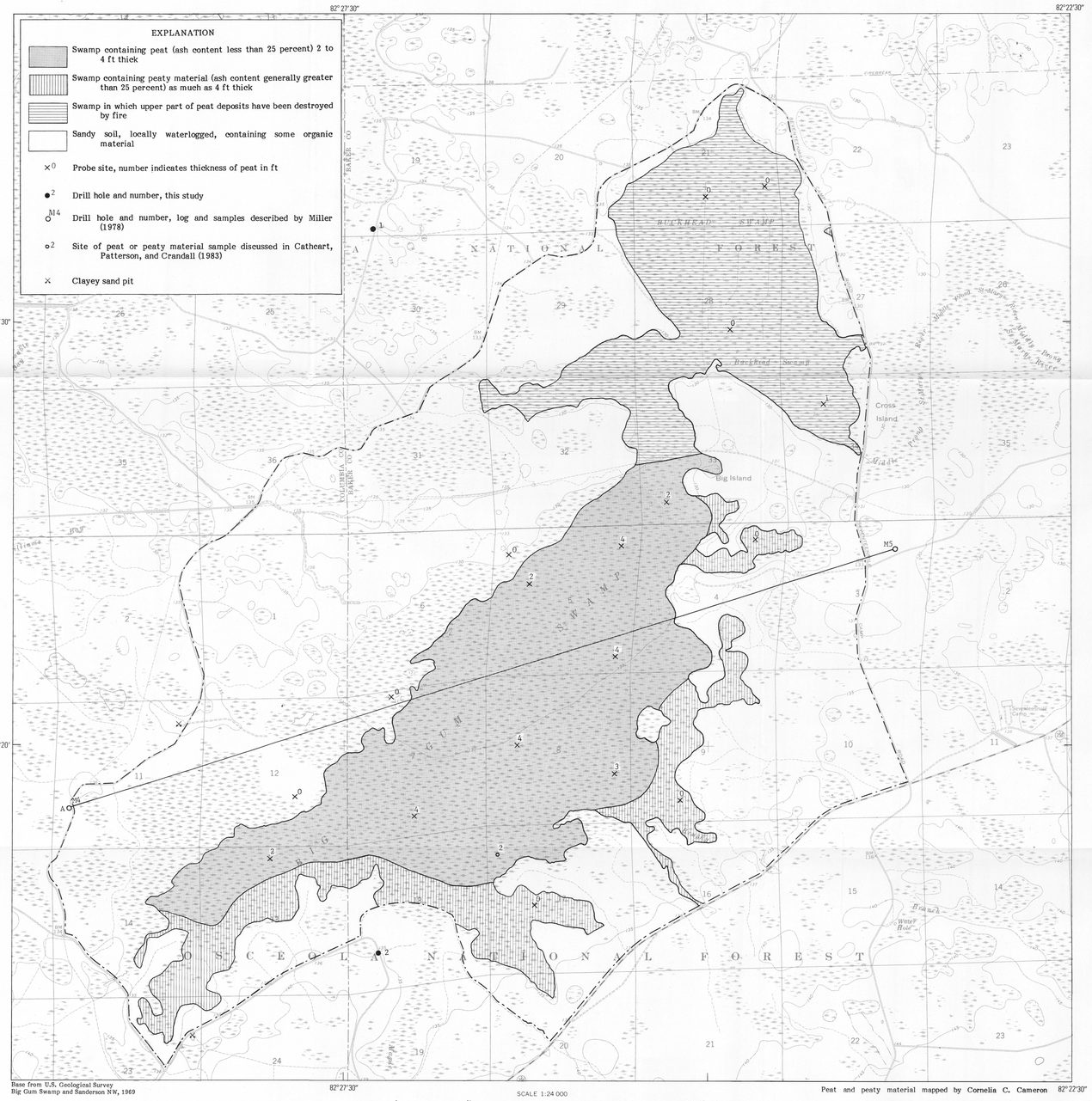
The surficial blanket of peaty material, muck, and soil is underlain over the entire area by 25-35 ft of unconsolidated sand and clayey sand containing some phosphate grains and dark heavy minerals near the base. The age of these unconsolidated sediments is uncertain because they contain no diagnostic fossils. They are considered to be of Quaternary age by Miller (1978), but may include strata of Pliocene age. These unconsolidated sediments rest unconformably on an unnamed upper Miocene formation, which is a phosphate-bearing clastic unit. This unnamed formation extends under the entire Osceola National Forest and forms the bedrock of the region.

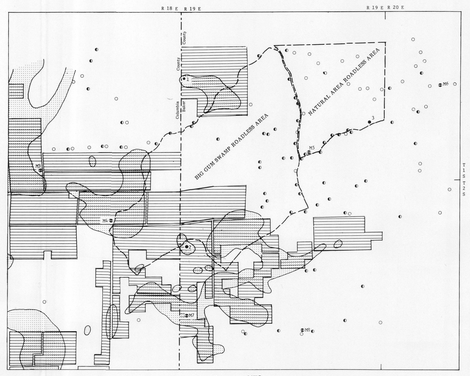
The Hawthorn Formation, the lower of the two Miocene formations, consists of interbedded clayey sand, hard sandy phosphatic dolomite and calcitic dolomite, sandy clay, and thin layers of chert and opaline silica. Well-rounded, highly polished, black, brown, gray, and white phosphate particles are present in varying amounts in all lithologies. The formation is 242 ft thick where penetrated by hole M5 (fig. 2). The Hawthorn is the principal phosphate-bearing formation in northern Florida.

About 3,300 ft of sedimentary rocks, ranging in age from Cretaceous to Eocene, underlie the Hawthorn unconformably and lie unconformably on Paleozoic-age crystalline and sedimentary rocks (fig. 1). Applin and Applin (1965) show that Lower Cretaceous strata are present at dry hole 1 (fig. 1), located in northwest Nassau County, but are probably missing in the subsurface of the Big Gum Swamp area. About 1,200 ft of Upper Cretaceous sandstone, shale, limestone, chalk, dolomite, and gypsum beds, divided into four formations, are present in the region of the Osceola National Forest (fig. 1). The Cretaceous beds are overlain by about 535 ft of the Cedar Keys Limestone of Paleocene age, and about 1,330 ft of limestone of Eocene age divided into the Oldsmar Limestone, the Lake City Limestone, a thin unnamed unit, and the Ocala Limestone. The Ocala is an important source of limestone, quarried for several purposes in northern Florida.

The Mesozoic and Cenozoic sedimentary rocks underlying the Big Gum Swamp Roadless Area dip gently and thicken considerably in an eastwardly direction (fig. 1). The area is on the eastern flank of the Peninsular Arch, a broad anticline the axis of which extends from Hamilton County, west of the area, to Palm Beach County to the south, a distance of nearly 300 mi (Applin and Applin, 1967, p. 30). In the vicinity of the Big Gum Swamp the Cretaceous beds are 1,200 ft thick and the Cenozoic rocks are about 2,100 ft thick. The St. Mary's River Oil Co. dry hole (fig. 1, dry hole 3), 37 mi to the northeast, penetrated Cenozoic beds 1,264 ft thick and Cretaceous rocks 1,890 ft thick (Applin and Applin, 1944; 1965; 1967).

No faults have been recognized in the Big Gum Swamp area. However, strata have undoubtedly been disturbed in many places by slumping into solution cavities.





EXPLANATION

- Area shown by U.S. Bureau of Land Management (1974 XI-3) as containing large or small phosphate deposits of non-commercial value
- Area for which mining lease applications were filed as of 1973 (U.S. Bureau of Land Management, 1974, XI-3)
- Company phosphate prospect hole (Crandall, 1981) and U.S. Minerals Management Service unpublished nonproprietary data
- Hole from which samples were evaderted and tested
- Hole for which no test data was reported, includes those penetrating no rich phosphatic materials
- M4 Ground-water research well, core described by Miller (1978) referred to in text by number
- 3 Drill hole, this investigation, referred to in text by number
- Study area boundary

Figure 3.—Locations of areas containing large and small phosphate deposits of non-commercial value, mining lease applications, and drill holes in the vicinity of the Big Gum Swamp and Natural Area Roadless Areas.

Table 1.—*Analytical data of phosphate samples from drill holes 1 and 2*

Analyses by Pembroke Laboratories under contract to the U.S. Geological Survey and U.S. Bureau of Mines. Uranium analyses by L.S. Sherlock and Nancy J. Nelson, Branch of Exploration Research, U.S. Geological Survey.

Drill hole number[1]	Depth in feet		Weight in percent	Analytical data, in percent: H.P.L.[2]	P_2O_5	A.I.[3]	Fe_2O_3	Al_2O_3	CaO	MgO	CO_2	F	U ppm	Ratios: CaO/P_2O_5	F/P_2O_5
1	28-41	+20 (pebble)	8.5	45.51	20.83	18.08	2.62	0.83	38.04	3.60	9.33	2.31	88	1.826	0.111
		-20 + 150 (feed)	72.09	25.78	11.80	63.19									
		Concentrate	23.48	68.43	31.32	4.04	1.34	1.51	46.78	0.76	3.74	3.83	45.51	1.49	0.122
		Tail	48.61	2.19	1.00										
		-150 (slime)	19.35	27.75	12.70								34		
		Total Rock	100.00	27.09	12.40	58.76							18		
2	24-50	+20 (pebble)	2.16	35.14	16.08	27.50	2.28	1.85	32.26	5.31	11.71	1.97	110	2.006	0.123
		-20 + 150 (feed)	76.53	9.40	4.30	85.97									
		Concentrate	9.33	65.88	30.15	4.46	2.69	1.04	48.50	0.92	4.36	3.81	77.75	1.61	0.126
		Tail	67.20	1.53	0.70										
		-150 (slime)	21.31	2.62	1.20								6		
		Total Rock	100.00	8.52	3.90	78.13							11		
	83-98	+20 (pebble)	45.70	7.78	3.56	33.83	0.62	0.96	23.09	12.64	23.29	0.61	-	6.48	0.171
		-20 + 150 (feed)	36.93	3.93	1.80	80.10									
		Concentrate	3.44	22.46	10.28	10.96	0.88	0.58	34.77	13.24	27.65	1.29	98	3.38	0.125
		Tail	33.49	1.53	0.70										
		-150 (slime)	17.37	3.28	1.50								10		
		Total rock	100.00	5.58 (calculated)	2.55										

[1] Drill holes located on figure 2
[2] Bone phosphate of lime
[3] Acid insoluble

Table 2.—*Selected exploratory oil and gas data for the Osceola National Forest and surrounding region*

(Source: Florida Bureau of Geology, oil and gas reports and records.

Florida Bureau of Geology number	Dry hole number (fig. 1)	Company or owner name	Dry hole or farm name	County	Sec.	T.	R.	Year of completion	Elevation of derrick floor	Total depth of hole (ft)
77	1	Humble Oil and Refining Company	#1 J.P. Cone et ux	Columbia	22	1N	17E	1948	141	4444[1]
59	2	Hunt Oil Co.	#1 H.L. Hunt	Baker	21	1N	20E	1947	139	3349[1]
W336	3	St. Mary's River Oil Corp.	Hilliard Turpentine Co. #1	Nassau	19	4N	24E	1949	118	4817[1]
449	4	Pan American Petroleum	#2 ITT Rayonier	Nassau	irreg. 35	3N	27E	1970	34	5469
143	5	Humble Oil and Refining Co.	#1 Squire Taylor	Suwanee	25	2S	13E	--	110	3684
57	6	Sun Oil Co.	J.H. Tillis #1	Suwanee	28	2S	15E	1947	162	3568[1]
93	7	Sun Oil Co.	#1 M.W. Sapp	Columbia	24	2S	16E	1949	138	3311[1]
402	8	Thomas A. Durham	Monticello Drug Company	Duval	23	1S	24E	1969	91	4192
653	9	Getty Oil Co.	Haimes, Morrison, and Melton #21-8	Columbia	21	3S	17E	1973	191	2898
124	10	Gulf Oil Corp.	Kie Vinning	Columbia	2	4S	15E	1950	117	3479[1]
666	11	Getty Oil Corp.	#1 J. Marsh & Sons et al 33-16	Columbia	33	3S	17E	1973	157	3195
109	12	Sun Oil Co.	A.B. Russell	Suwanee	8	5S	15E	1949	96	3139
104	13	Sun Oil Co.	W.F. Johnson	Columbia	27	4S	16E	1949	87	3051[1]
111	14	Sun Oil Co.	#1 Ruth M. Bishop	Columbia	10	4S	17E	1949	174	2828[1]
956	15	Robert Neuhauber	Owens Illinois Glass #1	Columbia	6	4S	18E	1978	190	2863
338	16	Gilbert Thayer and Sam Davis	Francis Ripley et al #1	Columbia	23	4S	17E	1965	173	3055
339	17	J.S. Michaels Co.	Fancies P. Ripley et al #1	Columbia	15	4S	18E	1965	156	3078
126	18	National Turpentine & Pulpwood Co.	Fee 1	Baker	7	4S	19E	1950	155	3941[1]
610	19	Thomas A. Durham	#B-1 Gilman Paper Co.	Duval	17	3S	23E	1969	94	3510
45	20	Sun Oil Co.	#1 Earl Odom	Suwanee	31	5S	15E	1947	73	3157[1]
107	21	Sun Oil Co.	#1 Clarence Floyd et al	Columbia	11	5S	17E	1949	125	2928[1]
680	22	Wilford Croft	#31-7	Union	31	4S	19E	1973	145	3061
465	23	INEXCO Oil Co.-- Pan American Petroleum Co.	Gilman Paper Co.	Bradford	22	4S	22E	1971	148	3164
390	24	R.C. Bradley	Brunswick Pulp & Paper Co. #1	Columbia	18	6S	17E	1968	96	3097
650	25	Getty Oil Co.	Raleigh Billings #4-1	Columbia	4	6S	18E	1973	156	3015
399	26	R.C. Bradley	J.M. Carter #1	Columbia	2	6S	16E	1968	80	3115
41	27	Tidewater Associated Oil Co.	#1 M.F. Wiggins	Bradford	15	6S	20E	1947	141	3167[1]
386	28	E.I. Dupont De Nemours Co. Inc.	--	Clay	17	5S	23E	1964	175	3509
50	29	Humble Oil and Refining Company	Foremost Properties, Inc. #1	Clay	4	6S	25E	1947	115	3862[1]

[1] hole penetrated Paleozoic strata (Puri and Vernon, 1964, plate 1)

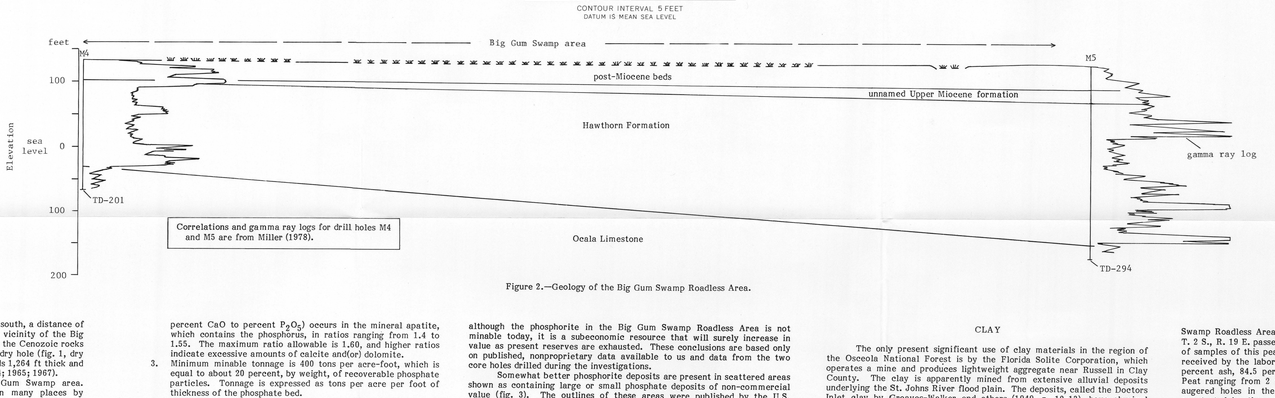


Figure 2.—Geology of the Big Gum Swamp Roadless Area.

Characteristics of Minable Phosphate Deposits

The economic limits for phosphate deposits of Florida are listed below. The maxima and minima listed are estimates of industry standards, based on current company practice.

1. The phosphorus content of the recoverable phosphate products is expressed as percent phosphorus pentoxide (P_2O_5) or percent bone phosphate of lime (BPL). BPL is equal to percent P_2O_5 x 2.185. The minimum in minable deposits is 60 percent BPL, or about 28 percent P_2O_5.
2. Excessive amounts of iron, aluminum, magnesium, and calcium oxides in the phosphate products have a deleterious effect on processing the phosphate rock. The maximum Fe_2O_3 + Al_2O_3 allowable in commercial phosphate rock is 5 percent, and the maximum MgO is 1.0 percent. CaO (expressed as a ratio of percent CaO to percent P_2O_5) occurs in the mineral apatite, which contains the phosphorite, in ratios ranging from 1.4 to 1.55. The maximum ratio allowable is 1.60, and higher ratios indicate excessive amounts of calcite and(or) dolomite.
3. Minimum minable tonnage is 400 tons per acre-foot, which is equal to about 20 percent, by weight, of recoverable phosphate particles. Tonnage is expressed as tons per acre per foot of thickness of the phosphate bed.
4. Minimum minable thickness for a phosphate bed is 3 ft; this is the minimum that can be mined using large draglines.
5. The thickness of overburden that can be removed in profitable mining is expressed as the ratio of this thickness to thickness of the phosphate bed. The maximum is 5 to 1.
6. The present maximum thickness of overburden plus phosphate that can be profitably mined in Florida is 200 ft; however, the maximum applies only to high-grade deposits where the phosphate bed is more than 25 ft thick. Maximum limits of depth of phosphate strip mining in northern peninsular Florida are presently no more than 150 ft.

Characteristics of the Phosphate Deposits in the Big Gum Swamp Roadless Area

Overburden—The overburden includes all of the noneconomic materials that overlie the phosphate deposit. Stratigraphically, it includes unconsolidated sediments of possible Miocene and Pliocene age and of Pleistocene and Holocene age. The overburden ranges from 15 to about 70 ft in thickness, and the only systematic variation is a tendency for thickness to increase from west to east. The overburden averages about 30 ft in thickness in the western part of the forest. It is about 50 ft thick east of the Big Gum Swamp Roadless Area, as indicated by the data from hole 3 (fig. 3) where the top of the analyzed sample was at 55 ft below surface. The basal part of the overburden includes rocks of the Hawthorn Formation.

Phosphorite—Thickness of the phosphate rock (phosphorite) intersected by the company prospect holes drilled in and around the Big Gum Swamp Roadless Area ranges from 0 to 66 ft (Crandall, 1981, table 1), and the average is about 23 ft. The total thickness of the overburden plus phosphate penetrated by all drill holes is less than 100 ft, and the ratio of the thickness of the overburden to phosphorite in most of the area explored is less than 5 to 1.

Evaluation of the phosphorite—Twenty-three of 30 holes drilled along boundary roads and in the central part of the Big Gum Swamp Roadless Area (fig. 3) by American Metal Climax, Inc. penetrated phosphorite beds (Crandall, 1981). The average thickness of this phosphorite is 23 ft, and the average thickness of the overburden above is 33 ft. Samples from 22 drill holes contained an average of 2.6 percent pebble (+20 mesh or +1 mm) phosphate, and samples from 20 drill holes contained an average of 18.5 percent concentrate (-20 to 150 mesh or -1 mm to 0.1 mm) phosphate. The average P_2O_5 content of the pebble phosphate was 20.94 percent and the average for the concentrate phosphate was 31.17 percent. The ratio of overburden thickness to phosphorite in the strata penetrated by the 23 drill holes ranges from a low of 0.3 to 1 to a high of 5.1 to 1, and the average is 1.4 to 1.

During the present investigation, two core holes (figs. 2 and 3, holes 1 and 2) were drilled near the Big Gum Swamp Roadless Area. Hole 1 was drilled to a depth of 143 ft, and a core sample from the 28- to 41-foot depth interval was tested (table 1). Hole 2 penetrated to a depth of 135 ft, and core samples from depth intervals of 24 to 50 ft and 83 to 98 ft were tested.

The phosphate deposits in the Big Gum Swamp Roadless Area are not economic (minable at a profit) by today's standards and may not become economic until deposits in other regions that are currently being mined are depleted. The concentrate fraction (-20+150 mesh) from drill hole 1 (table 1) is barely economic in all criteria, but the pebble (+20 mesh) fraction of this sample is not economic in any of the criteria. The top sample from drill hole 2 (table 1) is not economic, although some of the characteristics of the concentrate fraction are close to the economic limits. The bottom sample from drill hole 2 (table 1) is not economic in any of the criteria. Data from company drilling (Crandall, 1981) indicate that the samples analyzed are equivalent to the shallow samples shown on table 2. This shallow phosphate bed is probably the unnamed upper Miocene formation and is close to being economic. The recoverable phosphate of concentrate size contains somewhat more than 28 percent P_2O_5 (above the minimum cutoff), the overburden-to-phosphorite thickness ratios are favorable, and the total Fe_2O_3 + Al_2O_3 percents are slightly below the maximum. The other criteria for economic phosphate deposits are commercial utilization for these deposits. The recoverable phosphate concentrate is high in both the ratio of CaO to P_2O_5 and in MgO content, and the tonnage is slightly low. The pebble fraction is not usable—none of the criteria meet the economic standards and this fraction would have to be discarded or perhaps treated to upgrade the material to meet the standards. Therefore, although the phosphorite in the Big Gum Swamp Roadless Area is not minable today, it is a subeconomic resource that will surely increase in value as present reserves are exhausted. These conclusions are based only on published, nonproprietary data available to us and data from the two core holes drilled during the investigations.

Somewhat better phosphorite deposits are present in scattered areas shown as containing large or small phosphate deposits of non-commercial value (fig. 3). The outlines of these areas were published by the U.S. Bureau of Land Management (1974, p. XI-5). The areas were plotted using proprietary company drilling data that cannot be used in this report. Nevertheless, the description of these areas as being of non-commercial value agrees with our conclusion that the phosphorite in the Big Gum Swamp is subeconomic, but may increase in value in the future.

Even though the phosphate deposits may increase in value in the future, Section 5 of the Florida Wilderness Act of 1984 (Public Law 98-430, September 28, 1984) specifies out steps that would have to be taken before the phosphate in the Osceola National Forest could be mined as follows:

SEC. 5. (1) The Department of the Interior shall not issue phosphate leases in the Osceola National Forest, Florida, unless and until the President transmits a recommendation to the Congress that phosphate leasing be permitted in a specified area in the Osceola National Forest. Notice of such transmittal shall be published in the Federal Register. No recommendation of the President under this section may be transmitted to the Congress before ninety days after publication in the Federal Register of notice of his intention to submit such recommendation.

(2) FINDINGS.—A recommendation may be transmitted to the Congress under paragraph (1) if the President finds that, based on the information available to him—

(i) there is a clear and present national need for the phosphate resulting from a domestic shortage of phosphate reserves, and

(ii) such national need outweighs the overall public values of the public lands involved, including the wilderness area designated in section 1(3) of this Act and any adverse environmental impacts which are likely to result from the activity.

(3) REPORT.—Together with his recommendation, the President shall submit to the Congress—

(i) a report setting forth in detail the relevant factual background and the reasons for his findings and recommendation;

(ii) a statement of the conditions and stipulations which would govern the activity; and

(iii) in any case in which an environmental impact statement is required under the National Environmental Policy Act of 1969, a statement which complies with the requirements of section 102(2)(C) of such Act. In the case of any recommendation for which an environmental impact statement is not required under section 102(2)(C) of the National Environmental Policy Act of 1969, the President may, if he deems it desirable, include such a statement in his transmittal to the Congress.

(4) Approval.—Any recommendation under this section shall take effect only upon enactment of a joint resolution of Congress approving such a recommendation.

Uranium—Uranium, syngenetic in origin and substituting for calcium in the mineral apatite, is present in all marine phosphorites. Analyses of samples taken from cores at drill holes 1 and 2 (fig. 2) show that the probable samples contain more uranium than the concentrate samples, whereas the slime samples contain less uranium than either the pebble or concentrate, but about as much uranium as the total (head) samples (table 1). These generalizations, although based on only a few samples, are very similar to generalizations made for samples from the minable deposits of Florida (Cathcart, 1978).

Uranium has been recovered as a byproduct of the manufacture of phosphoric acid at several plants in the Land Pebble Phosphate District in Florida.

CLAY

The only present significant use of clay materials in the region of the Osceola National Forest is by the Florida Solite Corporation, which operates a mine and produces lightweight aggregate near Russell in Clay County. The clay is apparently mined from extensive alluvial deposits underlying the St. Johns River flood plain. The deposits, called the Doctors Inlet clay by Greaves-Walker and others (1949, p. 12-13), have physical properties that make it suitable for use in structural clay products.

Much very sandy clay and clayey sand and thin beds of clay were found in samples collected from the holes drilled during these investigations and the two holes described by Miller (1978). The principal clay mineral in the clayey sand is montmorillonite (smectite), and some thin beds are mixtures of montmorillonite and kaolinite. A bed of attapulgite (palygorskite) was penetrated at a depth of 203 ft at the bottom of hole 3 (fig 3).

The clays in the Big Gum Swamp area have no commercial value. The montmorillonitic and kaolinitic clays are too impure and(or) deeply buried to be mined at a profit. The attapulgite, which is the principal constituent of the fuller's earth mined extensively in Gadsden County, Florida, is far too deep to be strip mined.

HEAVY MINERALS

Heavy minerals have been mined for many years in parts of Florida east of the Big Gum Swamp Roadless Area. The principal mineral produced is ilmenite, the ore of titanium oxide, but staurolite, monazite, zircon, garnet, and kyanite are also recovered and sold (Garner, 1972, 1981). The heavy mineral deposits are in elevated beach accumulations, where they formed by the winnowing action of ocean waves and currents. Pirkle and Yoho (1970, p. 21) describe the Trail Ridge deposits as containing 4.5 to 6 percent heavy minerals. In a more recent report Pirkle and others (1977, p. 5) state that the Highland deposits in the Trail Ridge district contain an average of 3 percent heavy minerals.

No commercial heavy mineral deposits are known to be present in the Big Gum Swamp area, and it is very unlikely any will be found. The approximate 10 ft of relief in the area is evidence that no Pleistocene spit deposits, such as Trail Ridge, or elevated beach deposits are present. Therefore, the winnowing action by ocean waves or currents that is required to form heavy mineral deposits probably did not occur in the area. Also the post-Hawthorn sand beds in the Osceola National Forest are very low in heavy mineral contents. Samples of this sand from drill holes 1 and 2 were found to contain less than 1 percent heavy minerals other than phosphate. Mineral species found include ilmenite, garnet, zircon, staurolite, rutile, sillimanite, tourmaline, and kyanite. Monazite, present in small amounts in the Trail Ridge deposits, was not identified in any of the samples. Data from studies of samples from phosphate mines in Hamilton County, Florida (Cathcart, unpub. data) indicates that the heavy minerals in surficial sand above the phosphate deposits are present in amounts that average about 0.5 percent. Heavy minerals are also present in the phosphate beds, but they are so minor in amount that they are concealed by the abundance of heavy phosphate pellets. This content of heavy minerals is similar to the low concentrations in surficial sand, other than spit and elevated beach deposits, found throughout the large region east of the Big Gum Swamp Roadless Area by Pirkle and Yoho (1970, table 9). Furthermore, an aeroradiometry map (U.S. Geological Survey, 1978) shows no anomalous radiation in the Big Gum Swamp area, whereas prominent radiation anomalies were recorded from Trail Ridge and other areas where heavy minerals have been mined.

LIMESTONE

The Ocala Limestone, quarried at many places in northern peninsular Florida (fig. 1), is a very pure limestone. The Ocala underlies the entire Osceola National Forest, but the top of the formation is 165-270 ft below the area and limestone cannot be quarried profitably at such depths in this area. Sandy carbonate rock makes up the lower part of the Hawthorn Formation throughout the area, but this rock is too low quality and too deeply buried to be economic.

PEAT

Peat is a naturally occurring accumulation of plant remains in swamps. The term peat, as defined by the American Society for Testing Materials (1969), is applied to organic material having an ash content not exceeding 25 percent on a dry weight basis. To have a resource potential for horticultural use, peat must have a thickness of 4 ft or more; for use as fuel it must be at least 5 ft thick. Organic deposits containing more than 25 percent ash are referred to as peaty material.

Peat and peaty material are scattered through the extensive cypress-black gum swamps in the southern two-thirds of the Big Gum Swamp Roadless Area (fig. 2). One hand-cored hole in the NW 1/4, sec. 8, T. 2 S., R. 19 E. passed through humus peat 2 ft thick. Laboratory analyses of samples of this peat showed 16.8 percent ash, 85.4 percent moisture as received by the laboratory, and a pH of 5.72 in the 1 ft and 17.4 percent ash, 84.5 percent moisture, and a pH of 3.68 in the lower 1 ft. Peat ranging from 2 to 4 ft in thickness was found in seven other hand-augered holes in the central part of the Big Gum Swamp. The peat penetrated by these hand-augered holes was evaluated by the empirical hand-squeeze ball-forming method that permits the quick determination of which material contains more than 25 percent ash and which has less. Peaty material was found in scattered areas along the southern margin of the Big Gum Swamp (fig. 2) and in the northern one-third of the swamp (labeled Buckhead Swamp on the base map, fig. 2). Peat was probably present in the Buckhead Swamp at one time but was destroyed by fire.

Peat having an average thickness of 3 ft extends over 2,640 acres in the southern two-thirds of the Big Gum Swamp Roadless Area. As an acre-foot of peat, air-dried, weighs about 700 tons, this equals approximately 1.6 million short tons in the Big Gum Swamp. Because none of this peat was found to be more than 4 ft thick and deposits of this thickness are irregularly distributed, the peat in the Big Gum Swamp Roadless Area is considered to be too thin for profitable mining by today's standards.

SAND

Clayey sand has been dug from one pit in the Big Gum Swamp Roadless Area for use in stabilizing Forest Service roads, and several pits have been dug in the Osceola National Forest for road materials. The clayey sand in the Big Gum Swamp area has no particular value because it is too fine grained for most construction uses and there are enormous resources of similar material in northern Florida.

OIL AND GAS

According to the reports and records of the Florida Bureau of Geology, many oil and gas exploratory holes have been drilled in the region surrounding the Osceola National Forest (fig. 1, table 2). To date, only a few shows of oil and gas have been found, and all of the holes have been dry. Of the 29 selected dry holes, only three were drilled deeper than 5,000 ft, and the deepest was 5,862 ft. One hole was 4,444 ft deep, and all other holes were less than 3,500 ft deep. Thirteen of the selected dry holes penetrated Paleozoic strata. Cole (1944, p. 96-109) included a driller's log of the St. Mary's Oil Corporation well, located 37 mi northeast of the Big Gum Swamp Roadless Area, that noted several shows of oil at a depth between 1,812-4,795 ft and evidence of gas at two intervals.

Although there are no reasons for optimism about a discovery of oil and gas in the Big Gum Swamp Roadless Area, the possibilities cannot be completely ruled out. The principal reasons for the unfavorable outlook are the large number of dry holes in the region (fig. 1) and the absence of the formations that contain oil and gas in the fields in southern and westernmost Florida.

The oil in the southern Florida fields is in Lower Cretaceous formations, and in the Jay field in the western Florida panhandle it occurs in the Upper Jurassic Smackover Formation. In the vicinity of the Osceola National Forest, the lowermost Upper Cretaceous formation lies unconformably on Paleozoic rocks.

Some possibility remains, however, for the discovery of oil and gas in deep rocks in the Big Gum Swamp Roadless Area. The Paleozoic rocks have not been adequately explored in the region of the Osceola National Forest and, according to one authority (Rainwater, 1971, p. 1311), rocks of Paleozoic age in