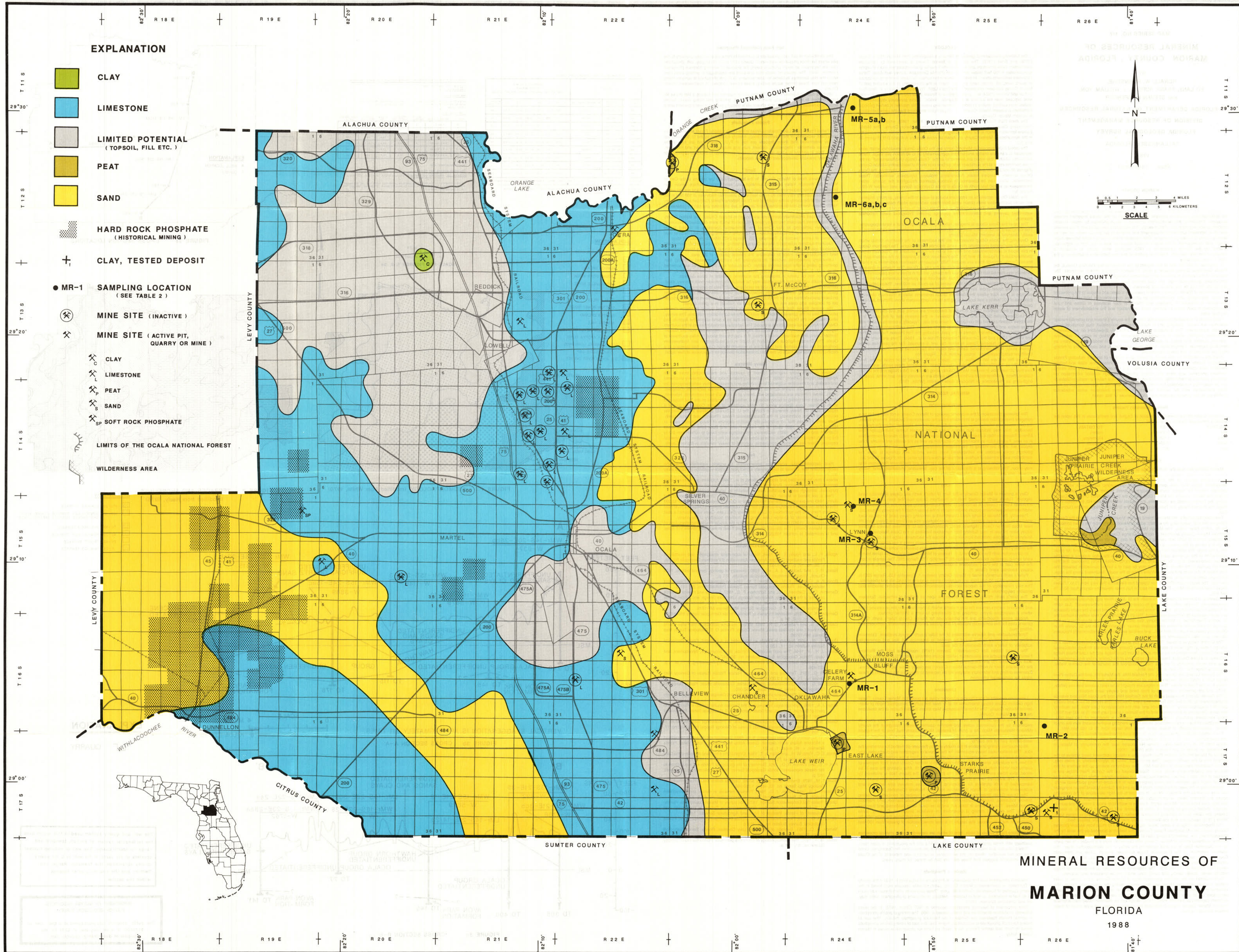




MAP SERIES NO. 117
MINERAL RESOURCES OF
MARION COUNTY, FLORIDA

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FLORIDA GEOLOGICAL SURVEY

TALLAHASSEE, FLORIDA
1988
ISSN 0085-0624

MARION COUNTY

INTRODUCTION

In recent years, considerable attention has been focused on Florida's rapid development, the accompanying population increase, and their effect on the state's important mineral resources. Frequently, this development occurred in areas undertaken by known mineral deposits, precluding extraction of the minerals. The economic association with these mineral resources represent substantial employment and income to the private sector as well as taxes to county and state governments. One response to this growing conflict between rapid growth and development of the state's mineral resources was in the form of legislation enacted by the Florida Legislature in 1985 requiring each county to establish a comprehensive land use plan. Additional guidelines and due dates were established by the 1986 Florida Legislature.

In response to this act and at the request of the Withlacoochee Planning Council, the Florida Geological Survey initiated a study of Marion County's mineral resources. The objective of this report is to interpret and summarize geologic data (i.e., core and well cutting descriptions, geophysical logs, and data derived from field reconnaissance) in a format appropriate for use by city and county planners.

A knowledge of Marion County's mineral resources is basic and integral to the process of initiating, developing, and implementing an effective comprehensive land use plan. This information is essential to planners and officials in their analyses of urban and rural development in such areas as zoning, road construction and the establishment of waste disposal sites.

Factors used in evaluating the economic value of the county's known and potential mineral resources are varied, changing and in many instances interrelated, thus complicating an accurate assessment. The evaluation process is inherently dependent on an extensive exploration program, which is a necessary precursor to mining in order to determine reserves, content and extent of specific mineral resources. In addition, such factors as operating expenses, transportation, beneficiation, reclamation, and capital costs of mining must be included in the overall calculations.

Resource evaluation for this report is based on a number of sources including Florida Geological Survey reports and unpublished data, field reconnaissance, state and federal statistical data, company reports, questionnaires, and numerous discussions with mining company personnel and state and federal officials. Although detailed information on company statistics is confidential, information of a more general nature is readily available or can be reasonably extrapolated from existing data. The diversity of sources as well as their close association with the various aspects of resource evaluation lends substantial confidence to the general assessments and inferences of this report.

Metric Conversion Factors

In order to prevent the awkward duplication of English and metric units in this report the following conversion factors are provided.

MULTIPLY	BY	TO OBTAIN
feet	0.3048	meters
miles	1.609	kilometers
acres	0.4046	hectares
tons	907.18	kilograms

GEOMORPHOLOGY

Marion County lies near the northern edge of the central (Mid-penninsular) physiographic zone of White (1970). This zone is characterized by a series of ridges and valleys trending approximately parallel to the Atlantic coast. Within the central zone, these distinct topographic highs and lows comprise additional geomorphic subdivisions which are generally named for nearby towns or geographic areas (Figure 1). These subdivisions include the Marion Upland, the Mount Dora Ridge, the St. Johns River Offset, the Central Valley, the Sumter Upland, the Ocala Hills, the Fairfield Hills, the Martel Hill, the Cotton Plant Ridge, the Western Valley, the Tsala Apopka Plain, the Brooksville Ridge and the Dunnellon Gap.

Two topographic highs, the Marion Upland and the Mount Dora Ridge, border the Central Valley on the east, separating the eastern edge of Marion County from the offset portion of the St. Johns River Valley. The Marion Upland is a series of small hills, extending from northern Marion County southward to northern Orange County. Surface and near surface sediments consist of sand with varying amounts of clay and silt material. The Mount Dora Ridge is a series of discontinuous hills, composed of clayey sand over all but the northern end of the ridge. The northern half of the ridge is composed of clean quartz sand. Air photo examination of the dune-like sand bodies superimposed on the ridge suggest a possible aeolian (wind-blown) origin for this sand (White, 1970). White (1970) proposed that this northern portion of the Mount Dora Ridge may be part of a former connection between the Trail Ridge to the north and the Lake Wales Ridge to the south. Southwest along the ridge, the clayey sand is insubstantial, which explain the elevations found at the crests of the ridge. The western part of the Marion Upland has elevations that vary from 75 to 175 feet above mean sea level (MSL). The eastern section has lower elevations ranging from 50 to 75 feet MSL.

At Sanford, in Seminole County to the south, the St. Johns River jogs abruptly westward for approximately 15 miles before resuming its coast-parallel course northward. Just north of Palatka in Putnam County, the river turns back sharply eastward nearly the same distance and again resumes its northward trend. This 65-mile-long offset to the river is named the St. Johns River Offset. In Marion County, this zone includes a hook-shaped area at Salt Springs as well as the extreme northeastern corner. Elevations within the St. Johns River Offset vary between 5 and 25 feet MSL, and surficial sediments are predominantly Holocene alluvium and relict Pleistocene marine sands.

The Central Valley is a broad, 75-mile-long low area containing the Oklawaha River and Orange Creek. It originates in southern Alachua County and extends through east-central Marion County, terminating to the south at the Mount Dora Ridge and the Lake Wales Ridge in Orange and Lake Counties. Near-surface sediments of the Central Valley are comprised of sand with minor amounts of silt and clay. Throughout the course of the Central Valley, elevations range from 25 feet to 70 feet MSL.

The Sumter Upland, the Ocala Hills, the Fairfield Hills, the Martel Hill, and the Cotton Plant Ridge form a north-south trending series of topographic highs that separate the Western Valley from the Central Valley. These ridges are thought to be relict coastal features (White, 1970), and are generally composed of thick sand and clayey sand deposits.

The Sumter Upland is located south of the Fairfield Hills and the Ocala Hills and extends southward for 35 miles into Sumter and Lake Counties. This region of sand and clayey sand hills is approximately 15 miles wide and, with the exception of Lake Weir, has relatively few lakes. Elevations at the northern end of the Sumter Upland vary from 75 to 100 feet MSL; these elevations gradually increase southward reaching a maximum of 140 feet MSL.

The Ocala Hills are a nine-mile-long series of hills trending southwestward from the city of Ocala. Composed chiefly of clayey sand, these hills range from 70 to 185 feet MSL.

The Fairfield Hills form an irregular 15 by 20 mile area of northwest Marion County. Surface and near-surface sediments are predominantly clayey sand with surface elevations that range from 80 to 210 feet MSL. Martel Hill, located near the community of Martel, is considered an outlier of the Fairfield Hills (White, 1970).

West of Martel Hill, the Cotton Plant Ridge has a distinct northwest trend relative to the general axis of the nearby ridges. This small ridge, which is approximately 16 miles long, attains maximum elevations of 168 feet MSL. The sediments making up the surface of this feature are predominantly white sand. Superimposed on the Cotton Plant Ridge are a number of hills with a surface pattern suggestive of aeolian dunes. White (1970) states that such an origin may explain their trend perpendicular to the dune-forming southwest winds.

Immediately to the west of the Cotton Plant Ridge and the Sumter Upland lies an elongated low area known as the Western Valley. In contrast to the high elevations of the bordering ridges, the Western Valley, which includes the Tsala Apopka Plain, ranges from 30 to 100 feet MSL over most of its 140 mile length. It varies in width from about 2 miles at one point in western Marion County to about 14 miles in Sumter and Hernando Counties. In Marion County, the valley floor is primarily limestone overlain by a veneer of sand or clayey sand. White (1970) speculates that the Western Valley may be an ancient stream bed.

The Brooksville Ridge is a large, linear, high extending 110 miles from eastern Gilchrist County southeast into southern Pasco County. This feature is bounded on the west by the topographically low, seaward-sloping plain of the Gulf Coastal Lowlands, and includes the extreme southwest corner of Marion County near Dunnellon. Here it is divided into two parts by the Dunnellon Gap, a low area containing the valley of the Withlacoochee River. The southern extension of the Brooksville Ridge continues through Citrus and Hernando Counties, finally terminating in Pasco County. Over its entire course, this ridge attains elevations that vary from 75 feet to greater than 300 feet MSL. In Marion County, elevations range from 75 feet to 170 feet MSL. The sediments which make up the Brooksville Ridge include sands, clayey sands, and sandy clay, which overlie limestone and dolomite.

Superimposed on the modern geomorphology of Marion County are a series of relict marine terraces reflecting higher sea level stands during the Pleistocene Epoch. The erosional processes associated with the former sea level highs helped carve the modern topography out of older geologic formations and largely determined present-day surficial sediment depositional patterns. Healy (1975) recognized six elevation-based marine terrace levels in Marion County. Figure 2 illustrates the relative positions and areal extent of these terrace elevation zones.

GEOLOGY

The following discussion of geology is primarily a compilation from Vernon (1951), Knapp (1978) and Scott (1979). The geology of Marion County is dominated by carbonate sedimentary rocks (limestone and dolomite) which overlie Precambrian rocks at depths approximately 4,700 feet below land surface (Florida Geological Survey well data). These carbonate sediments are in turn overlain closer to the surface by clastic sediments composed of quartz sand, silt, clayey sand and clay. Much of the stratigraphy of the western part of Marion County has been influenced by the Ocala Uplift. This structural feature as described by Puri and Vernon (1964) is "a gentle anticlinal flexure about 230 miles long and 70 miles wide exposed near the surface in west-central Florida." Rocks previously deposited and uplifted were uplifted relative to rocks in surrounding areas. This resulted in certain geologic formations in western Marion County occurring at higher elevations than the same formations in eastern Marion County.

The Avon Park Formation (Appin and Appin, 1944; Miller, 1986), which crops out in neighboring Citrus County, has no surface occurrences in Marion County. This Middle Eocene formation, which is the oldest stratigraphic unit to crop out in Florida, is only present in the subsurface in Marion County as shown on cross sections A-A' and B-B' (Figures 3b and 3c).

The oldest rocks exposed in Marion County are the Ocala Group limestones which were deposited in a shallow marine environment approximately 38 to 40 million years ago. These sediments, which in this report are referred to as the "Ocala Group Undifferentiated" on the cross sections occur at the surface or near surface over much of west-central Marion County (Figures 3b and 3c). Generally consisting of a soft, white, relatively pure limestone, the Ocala Group contains abundant fossils (foraminifers, mollusks, bryozoans, echinoids). These sediments, which can be observed in various quarries throughout the county, attain thicknesses up to 190 feet north of Ocala (Florida Geological Survey well number W-892, Figure 3c).

The Ocala Group represents an important source of water to the county, as many irrigation and public supply water wells obtain water from these sediments which make up part of the Floridan aquifer system. The productivity of the Ocala Group is enhanced by the numerous water-filled caverns and interconnected openings present throughout these carbonate deposits.

The top of the Ocala Group is irregular, reflecting the development of a karst topography. This topography, which is dominated by such karst features as sinkholes and depressions, is easily observed in western Marion County.

Overlying the Ocala Group limestones are the sediments of the Hawthorn Group which consist of interbedded phosphatic clay, sand, dolomite and limestone. The Hawthorn Group in this report is undifferentiated and referred to on the cross sections as "Hawthorn Group Undifferentiated" (Figures 3b and 3c). The Hawthorn occurs primarily in the eastern part of Marion County, although there are isolated "hills" capped by Hawthorn sediments in a linear trend extending northwest to southeast through the city of Ocala. The Hawthorn Group is generally less than 60 feet thick throughout the county, except in areas where paleosolvent etched (formed on top of the Ocala limestone), Hawthorn and younger sediments, which have filled in the old sinkholes, can attain thicknesses of as much as 400 feet. These paleosols are frequently found under the larger lakes in the eastern part of Marion County. One example is Lake Kerr where the Hawthorn Group sediments attain a maximum observed thickness of 100 feet in a well located along the lake's northwestern shore (Richard Johnson, personal communication, 1986).

Overlying the Hawthorn Group in much of the county are sands, silts and clay referred to as "Undifferentiated Sands and Clays." However, in the eastern part of the county is a distinctive reddish colored unit composed of sand and clay. Typically, it consists of sand with a clay matrix and occasional occurrences of quartz pebbles. This undifferentiated unit has been called several different names in the past, including the Fort Preston Formation (Puri and Vernon, 1964) and the Citronelle Formation (Pirklie et al., 1964). There are many "sand pits" in the Ocala National Forest in which this unit is exposed. For the purposes of the current study, these varicolored sands and clays will be referred to as "Plio-Pleistocene Undifferentiated Sediments" (cross section A-A', Figure 3b).

Above this unit are tan to white, loose, quartz sands referred to on cross section A-A' (Figure 3b) as "Undifferentiated Surficial Quartz Sand." In general, these sands, are usually less than 20 feet thick. In eastern Marion County along the Mount Dora Ridge and the Marion Upland, these undifferentiated surficial quartz sands are relatively clean and white, possibly originating as Pleistocene or Holocene dune deposits (White, 1970).

MINERAL RESOURCES

INTRODUCTION

The following discussion of the economic geology of Marion County is not intended to be a complete investigation leading to immediate industrial development because, in many cases, the data represents information on a single outcrop, pit or mine. However, where the data are favorable, they may indicate that certain areas merit warrant further investigation. The Mineral Resources Map is designed to present an overview of the major mineral commodities in an area. Factors such as thickness of overburden as well as the quality and volume of the deposit will affect the mining of the mineral commodity at any specific site. In contrast, geologic cross sections are extrapolated from cores and/or well cuttings to show the distribution and thickness of surface and near-surface stratigraphic units (Figures 3b and 3c). Occasional variations between the geologic cross sections and the Mineral Resources Map may occur. The following is a discussion of the clay, limestone, phosphate, sand, heavy mineral, and peat resources of Marion County.

Clay

Clay is present in Marion County in the form of fuller's earth and clayey (kaolinic) sand deposits. Fuller's earth is mined from the Hawthorn Group near the town of Reddick in northwest Marion County. A tan-to-red to white kaolin-bearing sand in the Plio-Pleistocene undifferentiated sediments occurs predominantly in the eastern half of the county (Figure 3b). Presently, the Marion County Road Department is removing clayey sand for use as a sand mining operation located in section 29, Township 17S, Range 26E. The sample is from the lower part of the Plio-Pleistocene undifferentiated sediments and is typically a white, clayey, kaolinic sand (Table 1).

Fuller's earth currently mined in Marion County (section 1, Township 13S, Range 20E) is approximately 20 to 30 feet thick and contains various amounts of sand, silt and phosphate. The clay mineralogy of the deposit includes montmorillonite, illite, sepiolite, smectite and possibly palygorskite (Patrick et al., 1983).

The fuller's earth mining operation utilizes the open pit method of extraction. Scrapers remove the vegetation, surficial sands and other extraneous overburden materials. Draglines and front-end loaders remove the clayey materials to the processing plant where they are cleaned, dried, grinding and classifying to form a finished product.

Animal waste absorbents are the primary use for Marion County fuller's earth. Other general uses for this commodity include oil and grease absorbents, fertilizers, pesticides and drilling mud.

Total production and reserve estimates of the fuller's earth are not available. Extensive drilling and laboratory testing would be needed to determine the size and commercial suitability of fuller's earth deposits in the area.

The United States Soil Conservation Service (1979) reports that both the Blitchton-Flemington-Kanapaha soil association (which occurs primarily north of U.S. Highway 27 and west of Interstate 75) and the Citronelle-Pastley-Easton soil association (which occurs west of the Oklawaha River in north-central Marion County) are clayey below depths of 40 inches. Extensive drilling and laboratory analysis will be required to determine the suitability of these areas for commercial utilization.

All companies mining limestone in the county employ the open pit method for extracting the rock. This method uses heavy equipment for the removal of vegetation and overburden prior to mining a new quarry. The amount of overburden can vary from a few inches to as much as 50 feet. For example, areas in the southwestern part of Marion County have thick deposits of overburden which may have potential as a local source of fill. After clearing the area to be mined, shot holes are frequently drilled into the rock and the quarry face is shattered by blasting. The shattered rock is then loaded by dragline or front-end loader into trucks and transported to rock crushers for processing. This process involves size reduction and subsequent screening to obtain various rock size fractions (Campbell, 1986).

The Ocala Group limestone is presently mined by a number of companies including Stavola Industries, Bowtell Construction, Monroe Mines, Ocala Bedrock, and Rainbow Marion Mines. This limestone is fairly soft and is removed using bulldozers and front-end loaders. The depth of mining is dependent on available equipment. Currently, some companies are mining limestone from a maximum depth of 65 feet below the water table by dragline. In many instances, this results in a total mined section of greater than 100 feet deep.

Limestone has a variety of uses, most of which are dependent on its physical properties and/or its chemical composition. In Marion County, the primary use of the commodity is for roadbase with minor amounts used for agricultural lime and the processing of glass. Limestone is not available, however, the widespread occurrence and thickness of the Ocala Group limestone suggest that these deposits can be mined for many years.

Hardrock Phosphate

Hardrock phosphate was first discovered in Florida by Albertus Vogt in 1889 in the vicinity of Dunnellon in southwestern Marion County. Later, valuable deposits were found in the nearby counties of Suwannee, Gilchrist and Levy. These sediments, which measure as much as 40 feet in thickness, consist of boulders, pebbles, small grains of phosphate, sand, clay and limestone (Vernon, 1951).

Peak production of hardrock phosphate occurred in 1907 (Olson, 1972). In the years following, production diminished and finally ceased in 1966. The mining of pebble phosphate in central Florida hastened the demise of the hardrock phosphate industry. The cost of mining hardrock phosphate is substantially higher than the cost of mining pebble phosphate mined in north and central Florida. As a result, no hardrock phosphate is mined in Marion County today.

Soft Rock (Colloidal) Phosphate

The distribution of soft rock phosphate is confined to those areas in close proximity to the pits where hardrock phosphate was mined. Quartz sand and a tan-to-gray, soft, phosphatic clay are separated as waste products during the process of washing hardrock phosphate (Vernon, 1943). The separated waste clay and sand are discharged to settling areas from which the clay becomes available for later recovery. Soft rock phosphate is currently being removed from these former waste settling areas by one company in southwestern Marion County.

Mining a deposit typically involves dicing of the material and loading it into trucks for transportation to the processing plant where drying, grinding and sizing occurs before shipping to nearby markets. Soft rock phosphate is primarily used as a feed ingredient and a fertilizer.

Pebble Phosphate

The Farles Prairie-Buck Lake Roadless Areas in the Ocala National Forest are underlain by phosphatic sediments of the Hawthorn Group. A study conducted by the U. S. Geological Survey determined that these deposits are low in P₂O₅ content and are high in the deleterious elements - magnesium, calcium, iron, and aluminum (Cathcart and Patterson, 1983). This, in addition to a high ratio of thickness-of-overburden to thickness-of-phosphate rock, may preclude development of these deposits.

Sand

Sand covers most of Marion County. In the topographically low regions of the Central Valley, the Western Valley and the Dunnellon Gap, sand forms a surface veneer over limestone. Thicker sequences of clayey sand and sandy clay cap the upland and hill areas. Thicknesses typically vary from 40 to 60 feet with a maximum thickness of 100 feet in the eastern half of the county in the vicinity of the Ocala National Forest (Cathcart and Patterson, 1983). These fine to coarse grained sand deposits are extensive and can be observed in numerous borrow pits located in the Ocala National Forest. At present, two commercial and two county road department operations are located in Marion County. The Marion County road department maintains two clayey sand pits, both of which were discussed previously in the section pertaining to clay. One of the commercial operations is located in the southeastern corner of the county (section 29, Township 17S, Range 26E) and the other near the town of Lynne (section 3, Township 15S, Range 24E) (Mineral Resources Map).

Spot samples collected in Marion County for testing, which included both channel and individual spot samples, were taken from existing pits (Mineral Resources Map). However, field inspections were made to determine the general geology of the area.

Laboratory procedures involved in analyzing the samples consisted of drying then quartering using a riffle type sample splitter. One quarter was then weighed and screened using a U. S. Standard Sieve Series. Data obtained are presented in Table 2. This information can be useful in assessing the economic potential of these deposits.

Test results indicate that these materials may be suitable for concrete, brick masonry, sand-cement riprap, sand-asphalt hot mix and as sand seal coat. Tests to determine suitability for glass manufacturing were not made. However, iron oxide coatings on the sand grains probably preclude their use for this purpose. Data from Table 2 represent only one particular set of samples and does not necessarily depict all material in a given deposit.

The United States Soil Conservation Service's (1979) soil survey of Marion County provides data on the general suitability of soils for use as construction materials. The survey, which includes the Ocala National Forest, states that as a sand source the Astabula and Chandler-Apopka soil associations are good. The Astabula association occurs in the southern region of Marion County west of Interstate Highway 75 in a narrow belt from the Marion-Sumter County line northward about 8 miles. It is also present about 12 miles southward of Ocala. The Chandler-Apopka association is associated with the sand deposits in the southwestern portions of the area studied and near Citra in northern Marion County. Soil sampling to a depth of 80 inches was made by the Soil Conservation Service for the purpose of this report.

Heavy Minerals

Heavy minerals were originally formed in igneous and metamorphic rocks of the Appalachian region (Gibson, 1959). The parent crystalline rocks were extensively weathered and eroded, and thereafter subjected to winnowing and abrasion as they were transported by fluvial and longshore marine currents before deposition in Florida sediments (Campbell, 1986). Heavy minerals are associated with nearly all of Florida's sand sediments. However, at the present time mining of heavy minerals is restricted to localities on the Trail Ridge and south of Green Cove Springs about 30 miles northeast of Marion County. As part of a regional study on heavy minerals in Florida, the U. S. Bureau of Mines investigated the occurrence of this commodity in the Ocala National Forest (Troen and Warr, 1949). Their study indicates that no economically valuable deposits of heavy minerals occur in Marion County. In a 1983 study of the Farles Prairie and Buck Lake Roadless areas (Cathcart and Patterson, 1983), exploratory well cuttings were found to contain 0.2 to 0.8 percent heavy minerals. This value is about one-tenth of the concentration of commercial deposits. There are no known commercial deposits of heavy minerals in Marion County.

Peat

Peat deposits occur where the accumulation of organic materials exceeds the decomposition rate. In order to commercially extract peat, surface vegetation is cleared away and the site dewatered. Bulldozer and/or draglines remove the peat material to a drying area where it may be shredded and stockpiled (Bond, et al., 1986). Additives can be mixed upon demand from the consumer. Peat from Marion County is likely to be used for horticultural purposes, although some quantities may be suitable for energy applications.

Peat is not mined in Marion County at this time. However, Davis (1946) reported that during 1940 peat was mined by the company, Materials Incorporated of Ocala, Florida, extending from 92,000 to 100,000 acres. Davis (1946) reported that the peat was used for horticultural purposes. Peat is not mined in Marion County at this time. However, Davis (1946) reported that during 1940 peat was mined by the company, Materials Incorporated of Ocala, Florida, extending from 92,000 to 100,000 acres. Davis (1946) reported that the peat was used for horticultural purposes.

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TABLE 2. LITHOLOGICAL ANALYSIS OF SAND IN MARION COUNTY, FLORIDA

DEPOSITS			LABORATORY TEST DATA								
SAMPLE NO.	LOCATION (TIE-POINT)	METHOD OF SAMPLING	GRAIN ANALYSIS								
			GRAIN SIZE AND CUMULATIVE PERCENT RETAINED								
			#	4	10	20	30	50	60	100	Wt. MODULUS
MP-1	10-246-220	CHANNEL	1.077	10.12	40.45	73.80	94.54	97.63	98.74	100.00	1.23
MP-2	10-246-220	CHANNEL	0.055	1.322	4.40	16.60	36.00	74.80	94.54	100.00	1.23
MP-3	10-246-220	CHANNEL		1.237	2.70	10.10	16.60	36.00	94.54	100.00	2.68
MP-4	10-246-260	SPOT	F	0.050	6.30	25.10	55.00	66.00	94.54	100.00	2.68
MP-5	10-246-280	CHANNEL	3.000	12.30	35.10	78.20	92.00	97.63	98.74	100.00	2.68
MP-6	10-246-280	CHANNEL	6.500	11.60	32.70	55.00	66.00	94.54	100.00	100.00	2.02
MP-8	10-246-250	CHANNEL	2.000	16.00	45.00	73.80	94.54	97.63	98.74	100.00	2.68
MP-9	05-246-240	CHANNEL	3.400	10.12	35.10	55.00	73.80	94.54	97.63	100.00	2.12
MP-10	10-246-220	CHANNEL	0.200	2.760	9.00	27.00	55.00	73.80	94.54	100.00	2.12