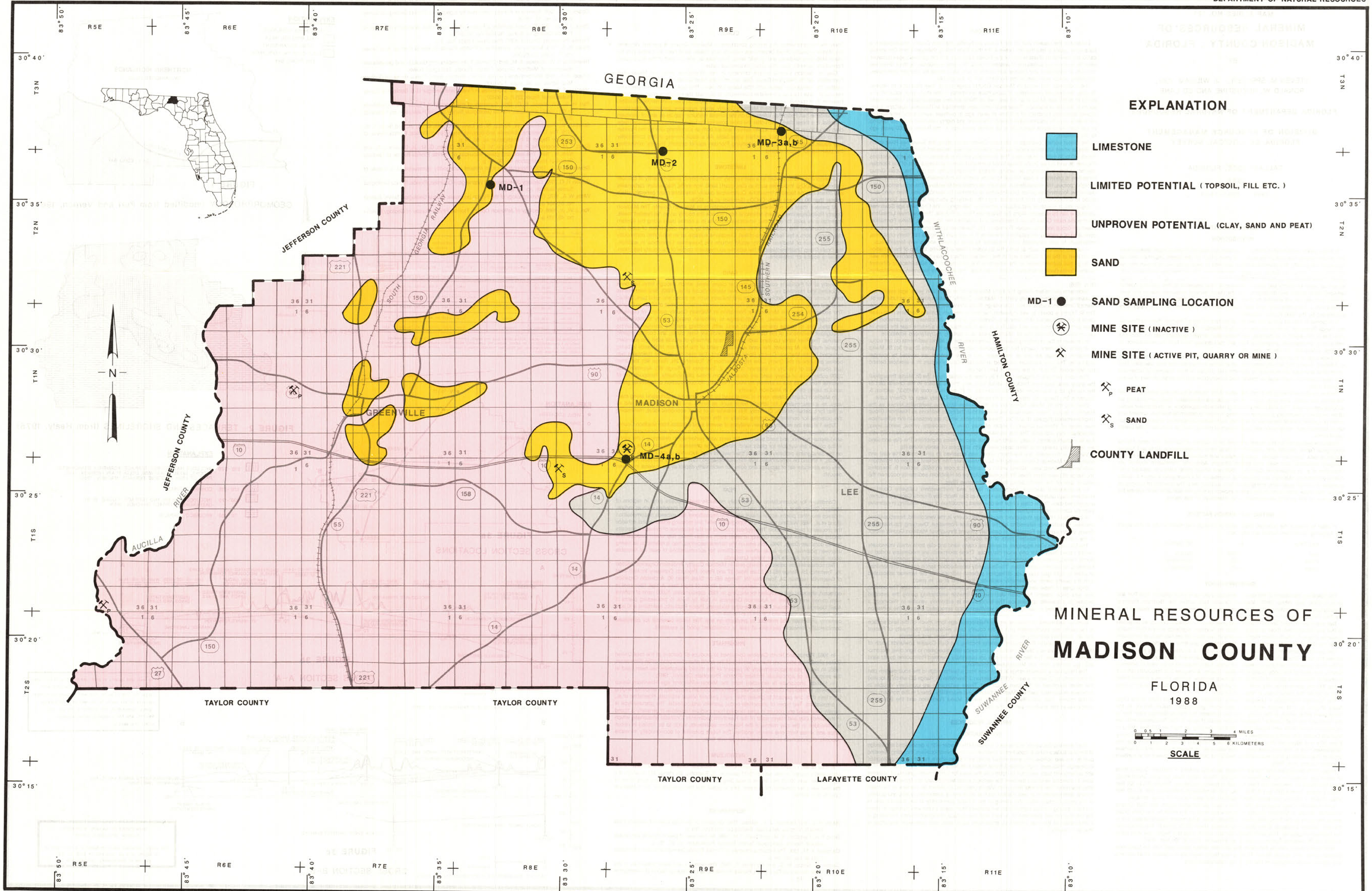
MAP SERIES NO. 121

FLORIDA GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES



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MINERAL RESOURCES OF MADISON COUNTY , FLORIDA

BY

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MADISON COUNTY

INTRODUCTION

In recent years considerable attention has been focused on Florida's rapid development and accompanying population increase, and their effect on the state's important mineral resources. Frequently, this development has occurred in areas underlain by known mineral deposits, precluding their future economic development. The economics associated 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 rules and regulations 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 North-Central Regional Planning Council, the Florida Bureau of Geology initiated a study of Madison County's mineral resources. The objective of this report is to compile, summarize and interpret geologic data (i.e., core and well cutting descriptions, geophysical logs and data derived from field reconnaissance) in a format appropriate for use by planners.

A knowledge of Madison County's mineral resources is basic and integral to the process of initiating, developing and implementing an effective comprehensive land use plan. This information and data are 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. This evaluation process is inherently dependent on an extensive exploration program, 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. Additional information sources are Hoenstine et al. (in preparation), Campbell (1986) and Knapp (1978). Although detailed information on company statistics are 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 to the various aspects of resource evaluation lend 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	2.471	hectares

GEOMORPHOLOGY

The following discussion of the geomorphology is primarily a compilation from Puri and Vernon (1964) and White (1970). Madison County falls within the Northern Proximal physiographic zone of White (1970). This zone is generally a highland area that extends from the Trail Ridge westward to the Apalachicola River Valley.

Two major geomorphic divisions within this zone occur in Madison County. As proposed by Puri and Vernon (1964), these divisions include the Northern Highlands and the Gulf Coastal Lowlands (Figure 1). The Northern Highlands extend over the northern two-thirds of the county while the Gulf Coastal Lowlands occupy the remaining one-third of Madison County.

The boundary between these two divisions occurs at a southward-facing escarpment named the Cody Scarp (Puri and Vernon, 1964). This escarpment is considered to be one of the most persistent topographic breaks in Florida. Easily observed to the west in Jefferson County, the trend of the Cody Scarp in Madison County is irregular and frequently difficult to observe. However, a series of north-south surface elevation profiles shows a distinct break at the 100 feet above mean sea level (MSL) contour. This 100 feet (MSL) elevation is used here to define the Cody Scarp in Madison County.

The Northern Highlands in Madison County includes all of the area north of the Cody Scarp (Figure 1). This region includes a prominent geomorphic feature known as the Tallahassee Hills, which, in the study area, lies between the Florida-Georgia state line to the north and the Gulf Coastal Lowlands to the south (Figure 1). The Tallahassee Hills are erosional-remnant hills and ridges with elevations ranging as high as 230 feet (MSL) in Madison County. Occurring extensively throughout the northern two-thirds of Madison County, these hills and ridges are characterized by gentle slopes and rounded tops. Although the Tallahassee Hills in this area have been highly dissected by stream erosion and subsurface solution, they probably once represented a nearly flat delta plain that covered all of northern Madison County (Yon, 1966).

Healy (1975) recognizes four marine terraces as being present in Madison County, three of which are located in the Northern Highlands. These latter three terraces, which Healy identifies based on elevation, are from highest to lowest: Hazlehurst Terrace (215 to 320 feet MSL), Coharie Terrace (170 to 215 feet MSL) and Sunderland/Okefenokee (100 to 170 feet MSL). Figure 2 depicts the approximate location and areal extent of these terraces.

With markedly lower elevations, the other major geomorphic region, the Gulf Coastal Lowlands, occurs in Madison County in an area bounded to the north by the Cody Scarp and to the south by the Taylor and Lafayette County lines. A prominent feature located within the Gulf Coastal Lowlands is the Wicomico Terrace. Healy (1975) extends this terrace into the Northern Highlands. This relict marine terrace, which reflects a higher sea level stand during the Pleistocene Epoch, occurs at an elevation of 70 to 100 feet (MSL).

Additional features include San Pedro Bay and river valleys associated with the Suwannee, Withlacoochee and Aucilla Rivers. Flowing into these rivers are numerous small streams and creeks which originate in the adjoining Tallahassee Hills.

GEOLOGY

Located in the eastern part of the Florida panhandle, Madison County encompasses a transitional geologic area that lies between the thick Early Tertiary (Paleogene) and Cretaceous carbonate sediments characteristic of the Florida peninsula and the generally age-equivalent siliciclastic-dominant sediments of western Florida. This area is underlain by thick limestone deposits of Oligocene and Eocene age which in turn are covered by younger limestones, dolomites, sands and clays in the northern half of the county.

The sediments that occur in Madison County range in age from Paleozoic to Recent. To date, the deepest penetration of subsurface sediments in the study area occurred at a depth of 10,150 feet (MSL) in an oil test well (W-15017) located approximately thirteen miles south of the city of Madison. These sediments were identified as Paleozoic quartzitic sandstones deposited hundreds of millions of years ago. In contrast, surface and near-surface sediments include unconsolidated sand, limestone and highly indurated dolomite ranging in age from the Eocene Epoch (36 to 58 million years ago) to the Recent (10,000 years ago to the present).

The oldest surface outcrops in Madison County occur along the Suwannee River south of Ellaville where limestone known as the Ocala Group was deposited during the Late Eocene Epoch (40 to 38 million years ago). This limestone, which is referred to in the cross sections (Figures 3b and 3c) as Ocala Group Undifferentiated, forms an integral part of the Floridan aquifer system and occurs at varying depths throughout the county. The Ocala Group limestone is generally a pale orange to white, poorly to moderately indurated, moderately to highly porous, microfossiliferous, partially recrystallized limestone. The occurrence of the distinctive foraminifera genus *Lepidocyclina* is common to abundant and often used as a guide in distinguishing this formation from the overlying younger Suwannee Limestone.

Exposures of limestone and dolomitic limestone belonging to the Oligocene age Suwannee Limestone can be observed along the Suwannee River at Ellaville. The Suwannee Limestone overlies the older Ocala Group limestones and underlies the younger St. Marks Formation, Hawthorn Group and Miccosukee Formation. The Suwannee Limestone is a marine limestone consisting of a variably recrystallized limestone. It is very pale orange to tan, finely crystalline, moderately to well indurated, with moderate to good porosity and is very fossiliferous.

In various locations, such as along the Suwannee River at Ellaville, the top of the formation is silicified at the land surface and in the near subsurface. It has been observed from well cuttings that dolomitization of the limestone has occurred in the subsurface at different depths (Florida Geological Survey unpublished data). This process of secondary dolomitization can also be readily observed in the outcrop area along the Aucilla River in Jefferson County (Yon, 1966).

Sediments deposited during the Early Miocene (17 to 24 million years ago) overlie the Suwannee Limestone in many parts of Madison County. These sediments include the St. Marks Formation, a white to very pale orange, finely crystalline, sandy, silty, clayey limestone. The St. Marks is poorly to well indurated, has low to medium porosity, contains molluskan casts and a few species of foraminifera (*Sorites* sp., *Archaias floridanus*). The formation has been partially dolomitized and silicified in the subsurface. In a sinkhole near the town of Lee in Madison County, the St. Marks occurs as a partially recrystallized limestone.

In contrast to the underlying Suwannee Limestone, the St. Marks sediments do not occur in all parts of Madison County but have sporadic occurrences (Figures 3b and 3c). St. Marks Formation outcrops are rare as the greater part of the deposits are covered by younger sediments. The only exposure observed in Madison County occurs in a sinkhole behind the Methodist Church in the town of Lee, Florida.

The cross sections in Figures 3b and 3c show the variability of the St. Marks throughout the study area. Sediment thickness varies from very thin to absent in the central part of the county to a maximum observed thickness of 20 feet in a core (W-15537, section 5, Township 2N, Range 9E) drilled in north-central Madison County west of Cherry Lake.

Overlying the St. Marks Formation are the younger Miocene sediments known as the Hawthorn Group. These sediments are referred to in the cross sections as Hawthorn Group Undifferentiated (Figures 3b and 3c). These sediments, which are present in the subsurface over most of Madison County, consist of pale olive to moderate yellow, sandy, waxy, phosphatic clay and sand. The clay contains phosphate grains and is interbedded with very fine to medium grained, clayey, quartz sand that also contains phosphate. The clay and sand are frequently cherty and often associated with stringers of sandy dolosilts.

Variable in thickness, the Hawthorn Group was observed to pinch out to the east and southeast of Madison County along the Suwannee River. The thickest section of Hawthorn sediments observed was 142-feet which occurred in a core (W-6558, section 9, Township 1N, Range 6E) near State Road 90. Sporadic outcrops of Hawthorn sediments occur on the eastern side of the county along the Withlacoochee River.

In southeastern Madison, northeastern Taylor and northwestern Lafayette Counties, Hawthorn clays underlie a broad low area known as San Pedro Bay (Florida Geological Survey unpublished data). These clays inhibit the downward percolation of water resulting in extensive swampy conditions throughout the area.

A prominent lithology throughout much of the county is the varicolored, heterogeneous complex of sediments referred to as the Miccosukee Formation. Overlying the Hawthorn Group, the Miccosukee Formation is generally present throughout Madison County except in the south and southeastern parts of the county.

The Miccosukee is an aggregate of lenticular, clayey sand and clay beds which individually can be traced laterally for only short distances. These sediments are moderately sorted to poorly sorted, coarse to fine-grained, varicolored, clayey quartz sands and montmorillonitic, kaolinitic, varicolored sandy clays. The frequently crossbedded sands contain thin laminae of white to light gray clay. X-ray diffraction patterns indicate that the laminae associated with the quartz sands are primarily kaolinite (Hoenstine et al., in prep.).

Exposures of these sediments are in many places deeply weathered laterites. The bedding that was once present has been destroyed by intense weathering giving the exposed sediments a massive appearance. The Miccosukee is extremely variable in thickness, a condition attributed in part to extensive weathering and associated erosion. The formation can be observed in numerous roadcuts throughout the northern part of the county.

Surficial sediments of Pliocene and/or Pleistocene age form much of the land surface in the south and southeastern part of the county. Less widespread sediments of Recent age are confined primarily to the present stream valleys, lakes and swamps.

The Pliocene and/or Pleistocene deposits forming the Gulf Coastal Lowlands south of the Cody Scarp are very fine to medium quartz sands with blue-green to light olive, montmorillonitic clay lenses. The Recent sediments are essentially reworked Pleistocene quartz sand and clay derived from the Miccosukee Formation.

The Pleistocene deposits range in thickness from a feather edge in the southeastern part of the county to 52 feet in a well (W-15960, section 3, Township 2S, Range 6E) which is located five miles southeast of the town of Lamont. These sediments are extremely variable in thickness throughout southern Madison County and essentially absent in the northern part of the county. They unconformably overlie the St. Marks Formation and the Suwannee Limestone in the southern part of the county.

MINERAL RESOURCES

INTRODUCTION

The following discussion is intended to provide the reader with a generalized knowledge of the near-surface mineral resources of Madison County. Several localities, including operating peat mines and borrow pits, were visited along with areas where, based on the geologists' knowledge, resources might occur (Mineral Resources Map). Additionally, geologic sampling and subsequent tests were run to determine the need for further investigations of potential sites. Occasional variations between the geologic cross sections and the Mineral Resources Map may occur. The Mineral Resources Map is designed to present an overview of the major mineral commodities in an area. Factors such as thickness of overburden, quality and quantity of the deposit could 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. Following is a discussion of the clay, limestone, phosphate, sand, peat, and petroleum resources of Madison County.

CLAYS

There are no commercial clay mining operations in Madison County at present. However, the Madison County Road Department extracts very clayey sand from its borrow pits for use in stabilizing roadways and athletic fields. This material, which is part of the Miccosukee Formation, currently has little other commercial value.

Clay in Madison County occurs primarily in two lithological units, the Miccosukee Formation and the Hawthorn Group. Clay occurs in the Miccosukee Formation as extremely variable, thin stringers or lenses with little lateral continuity. This type of occurrence precludes the use of these clays as a mineable commodity. In contrast, the Hawthorn clays are thicker. However, their sporadic occurrences place serious limitations on their commercial utilization. An exception occurs in southern Madison County where extensive continuous Hawthorn clays underlie San Pedro Bay, referred to on the mineral resource map as an area of unproven potential. It is these clays which offer the most potential for future commercial activity. These clays occur above the Floridan aquifer system and act both as a confining unit for the Floridan and to create the near-surface perched water table. As a result, mining of this commodity may cause contamination of the underlying Floridan aquifer system, thereby minimizing the potential for future mining.

LIMESTONE

Limestone is a term applied to a sedimentary rock comprised predominantly of calcium carbonate ($CaCO_3$). Impurities such as clay, quartz sand, iron oxide, magnesium carbonates and others may be found in limestone. Commercial quality limestone must generally attain greater than 90 percent purity $CaCO_3$ (Schmidt et al., 1979).

At present, there are no limestone quarry operations in Madison County. The Madison County Road Department orders limestone from outside the county on an "as needed" basis. Potential does exist for economic limestone deposits in a narrow band along the eastern county boundary. The potential in this area is enhanced by a thin overburden of sand and clay ranging from a few feet to tens-of-feet. Limestone suitable as an economic commodity from this region of Madison County would include the Suwannee Limestone. In addition, the Ocala Group Undifferentiated in the extreme southeastern corner of the county has potential as a source of limestone.

SAND

Nearly all of Florida is covered by sand or clayey sand, which through time, has been deposited and modified by different sea level stands (Scott et al., 1980). Sea level stands have formed terraces of thicker deposits and features such as dunes and sand bars. Deltaic sand and clayey sand of the Miccosukee Formation covers extensive areas of Madison County. The sediments from the Miccosukee Formation in Madison County consist of clayey to very clayey, silty, iron stained, reddish-orange to yellowish orange, poorly to moderately indurated, fine to coarse grained quartz sand, with mottling and fine laminae occurring throughout. Sediments of the Gulf Coastal Lowlands are finer, clayey, and contain organic material. The River Valley Lowland sediments consist primarily of alluvial sand and abundant organic material. At present, the sand and clayey sand of the Northern Highlands is being extracted by the Madison County Road Department. The road department maintains two borrow pits, one in the Cherry Lake region (section 31, Township 2N, Range 9E), the other just southwest of the city of Madison (section 2, Township 1S, Range 8E). Approximately 2,000 cubic yards of clayey sand are obtained from these pits annually. Transportation of material from these pits is entirely by truck. Presently, no construction or industrial grade sand is being mined in Madison County.

In Madison County, clayey sand is being used by the county for stabilization along roadways, as a base material for athletic fields such as tennis and basketball courts, and as a filler for baseball infields. Currently, this material is of small economic value, minimizing the potential for commercial mining activity in the near future.

Table 1 shows the results of screen analyses of several sand samples from Madison County. Tests indicate that the sands are suitable for concrete, brick masonry, sand-cement, riprap, sand-asphalt hot mix, and sand seal coat. No tests were performed to determine if the sands in the county are suitable for glass sand. However, the presence of an iron oxide coating on the sand grains probably precludes their use for manufacturing glass. In using the test results, it should be remembered that the data obtained from the sieve analyses represent only one particular set of samples and does not necessarily depict all the material in a given deposit.

PEAT

Conditions for accumulation of potentially mineable peat deposits exist in regions of Madison County. Peat, a product of partial decomposition of organic materials such as sedges, mosses and other plants, accumulates when the depositional rate exceeds decomposition (Bond et al., 1986). Wetland areas of low topographic relief and reducing environments enhance the process of peat formation. The highest potential for the existence of mineable deposits occurs in southern Madison County in areas such as San Pedro Bay where swamps and forests dominate (Davis, 1946). This area on the mineral resources map is referred to as having unproven potential. Other areas where conditions for accumulations of peat are favorable occur along the Aucilla River Valley Lowlands.

Two companies are presently mining peat in Madison County: Anderson Organics (section 35, Township 2S, Range 6E) on State Road 27 and Pasco Products Company located west of Greenville (section 24, Township 1N, Range 6E) on State Road 90. Anderson Organics maintains a 35 acre site with an average mining depth of eight feet. A high fiber peat is extracted, shredded and stockpiled for shipping. In 1985, approximately 70,000 yards of material were mined and shipped by Anderson Organics in bulk by truck to processing plants in Adell, Georgia and Cressant, Texas. The other company, Pasco Products, maintains a 10 acre site. There, peat is mined and top soil is extracted as a commercial by-product. Pasco Products currently processes and markets its products on site. The future potential for continued commercially mineable deposits of peat is considered good to excellent.

PHOSPHATE

In 1983, Florida and North Carolina combined to produce 87 percent of the total United States phosphate and more than 27 percent of the world phosphate production (Stowasser, 1985). In recent years approximately 90 percent of the mined phosphate has been used in the production of agricultural fertilizer (Florida Phosphate Council, 1987).

In Florida, phosphate is extracted from the Miocene-Pliocene age Hawthorn Group sediments. In Madison County, Hawthorn sediments contain phosphate in amounts ranging from less than one percent to greater than eight percent (visual estimate, Hoenstine et al., in preparation). Two types of phosphate occur, granular and colloidal. The granular type is usually weathered and occurs in sizes ranging from medium to pebble. It generally is found in the sandy clay and clayey sand of the Hawthorn sediments. Colloidal phosphate, which is embedded in the clay matrix of the Hawthorn sediments, tends to be limited in occurrence and varies from one area to another. The future potential of economically mineable deposits of phosphate is considered low at this time.

PETROLEUM

A total of five oil test wells have been drilled in Madison County. The maximum depth penetrated occured in test well W-15017 (section 22, Township 2S, Range 9E) in which the depth drilled was 10,149 feet before it was plugged and abandoned as a dry hole. None of the test wells encountered oil. Present data suggest that the potential for oil in Madison County is minimal.

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TABLE 1. SCREEN ANALYSES OF SAND IN MADISON COUNTY, FLORIDA

DEPOSITS			LABORATORY TEST DATA SCREEN ANALYSIS SIEVE NO. AND CUMULATIVE WEIGHT PERCENT RETAINED							
SAMPLE NO.	LOCATION (T. R. SEC.)	METHOD OF SAMPLING	4	8	16	30	50	100	200	*FINENESS MODULUS
Md 1	2N.8E.8ba	CHANNEL	-	-	0.447	3.644	25.678	77.627	96.738	2.04
Md 2	2N.9E.4aa	SPOT	-	-	0.184	2.901	18.198	58.630	92.328	1.72
Md 3a	3N.10E.31ab	CHANNEL	-	0.662	1.470	23.563	83.603	97.061	99.234	3.06
Md-3b	3N.10E.31ab	CHANNEL	-	0.242	3.949	28.485	79.277	95.764	99.685	3.74
Md 4a	1S.9E.6bb	CHANNEL	-	-	0.016	0.678	26.385	87.585	99.554	2.14
Md-4b	1S.9E.6bb	CHANNEL	-	-	0.149	2.220	13.271	48.471	90.968	1.55

*FINENESS MODULUS: A MEANS OF EVALUATING SAND AND GRAVEL DEPOSITS WHICH CONSISTS OF SIEVING SAMPLES THROUGH A STANDARDIZED SET OF SIEVES, ADDING THE CUMULATIVE WEIGHT PERCENTAGES OF THE INDIVIDUAL SCREENS, DIVIDING BY 100, AND COMPARING THE RESULTANT FINENESS MODULUS NUMBER TO VARIOUS SPECIFICATION REQUIREMENTS (BATES AND JACKSON, 1980).

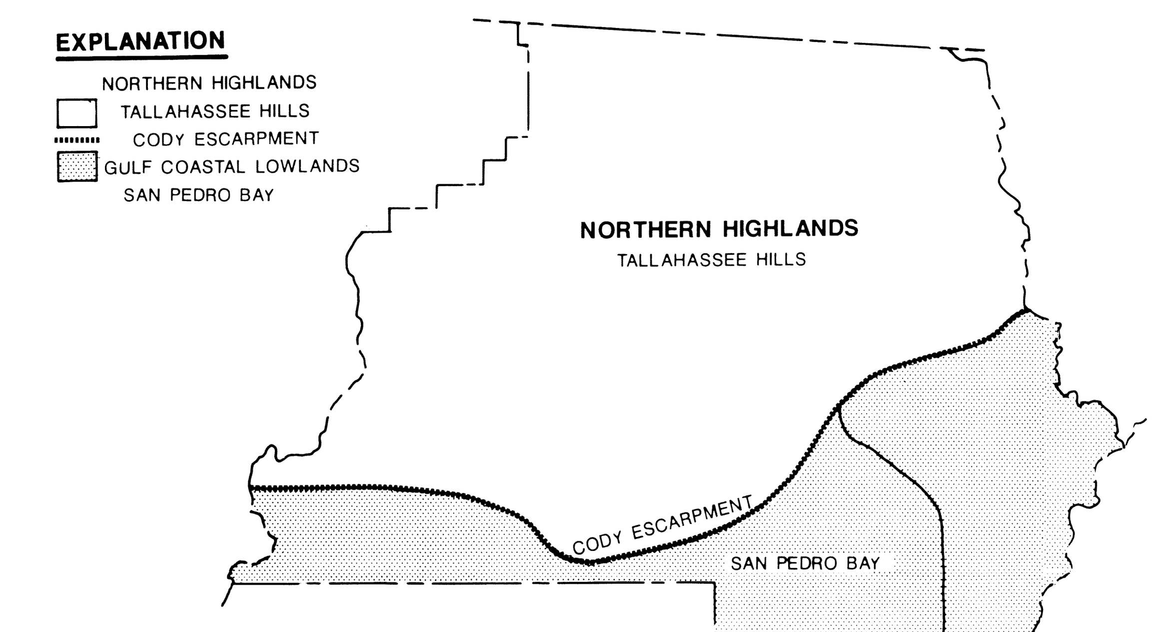
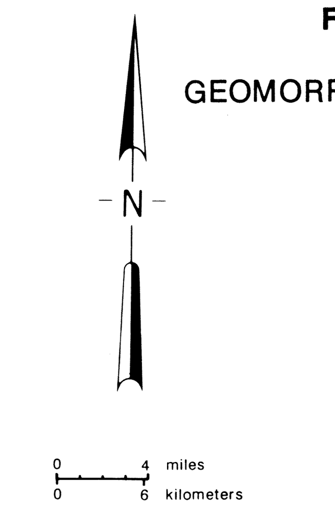


FIGURE 1

GEOMORPHOLOGY (modified from Puri and Vernon, 1964)



SCALE FOR FIGURES 1, 2, 3a

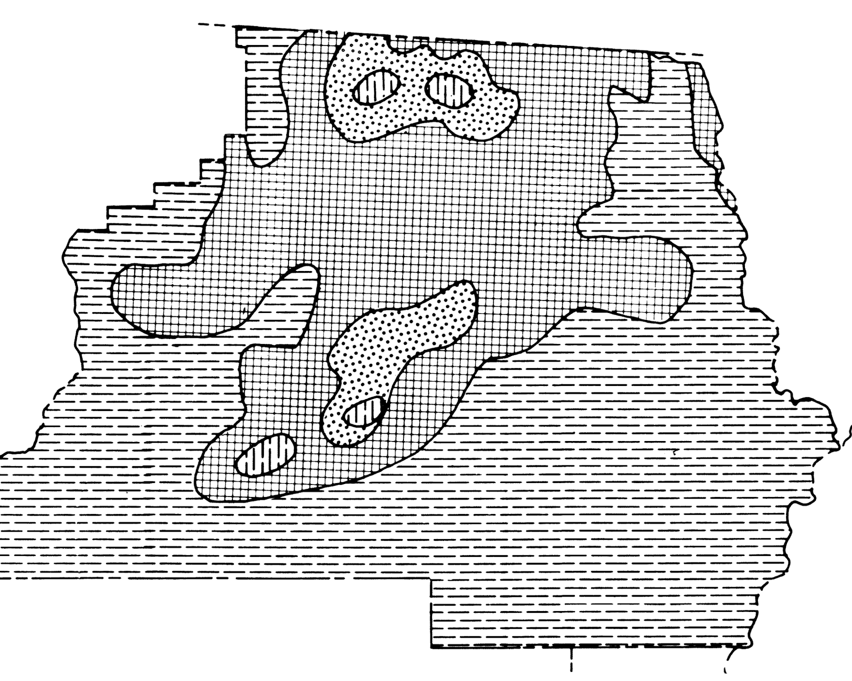


FIGURE 2 TERRACES AND SHORELINES (from Healy, 1975)

EXPLANATION

- 215'-320' INCLUDES HAZLEHURST TERRACE (FORMERLY BRANDYWINE) (COOKE, 1939), COASTWISE DELTA PLAIN (VERNON, 1942), PART OF HIGH PLIOCENE TERRACE (MACNEIL, 1950).
- 170'-215' COHARIE TERRACE
- 100'-170' INCLUDES SUNDERLAND TERRACE (COOKE, 1939), OKEFENOKEE TERRACE (MACNEIL, 1950).
- 70'-100' WICOMICO TERRACE

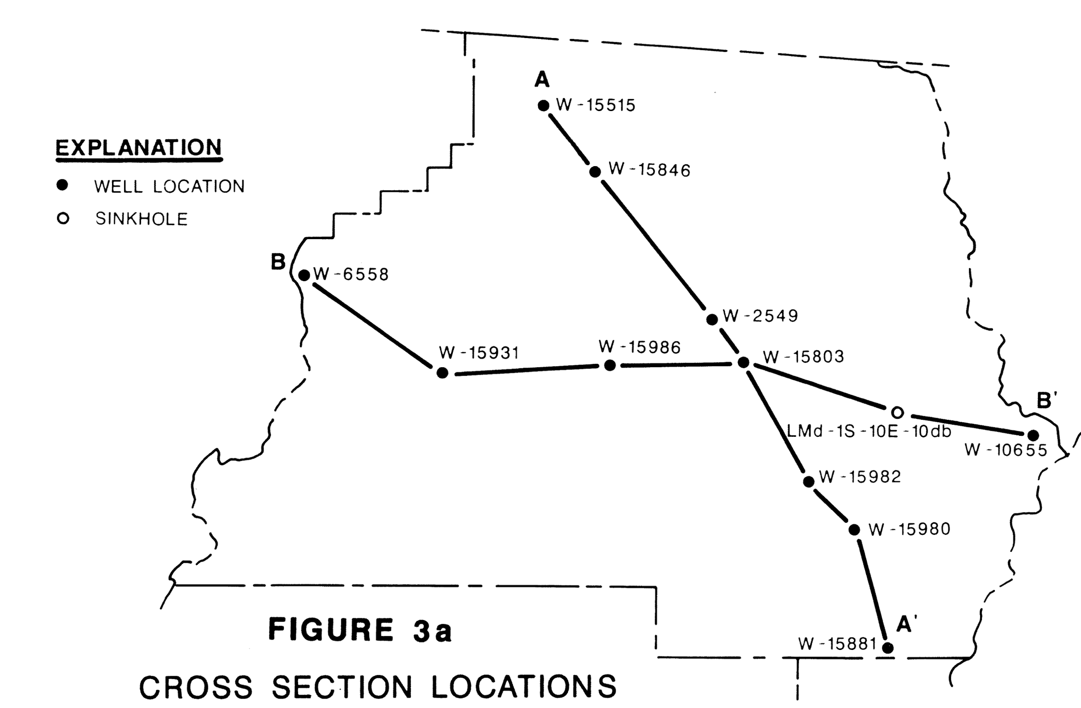


FIGURE 3a

CROSS SECTION LOCATIONS

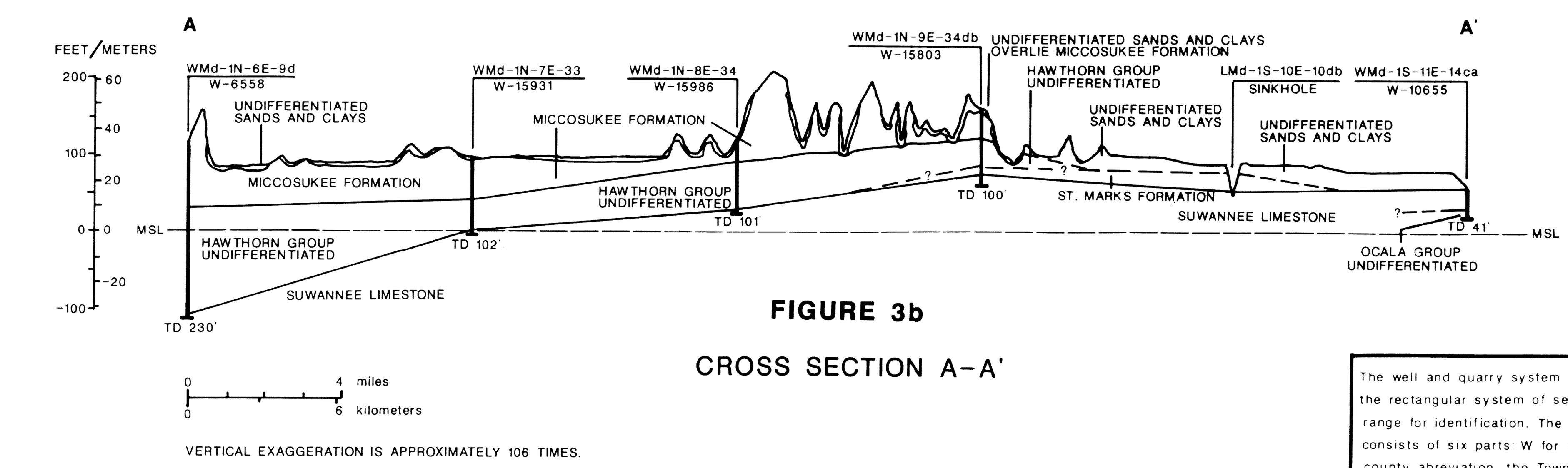


FIGURE 3b

CROSS SECTION A-A'

The well and quarry system used in this report uses the rectangular system of section, township and range for identification. The well or outcrop number consists of six parts: W for well or L for quarry, county abreviation, the Township, Range, and Section, and the quarter/quarter location within the section.

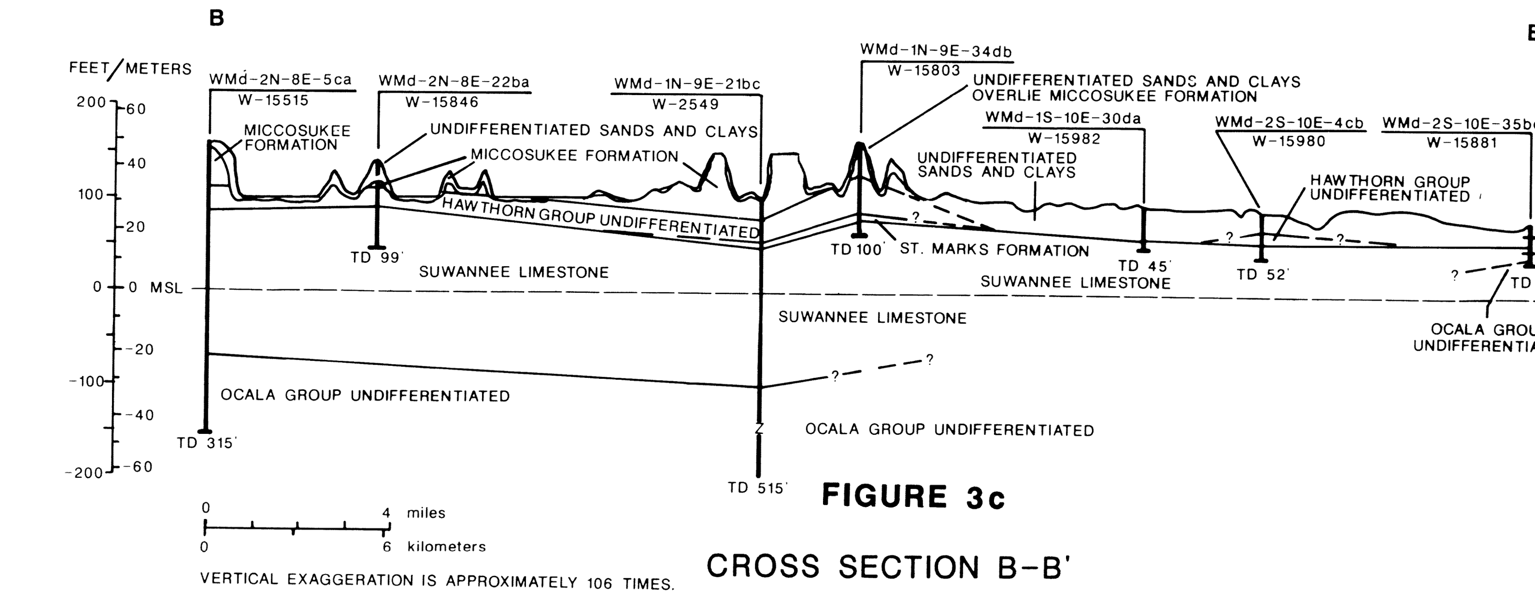


FIGURE 3c

CROSS SECTION B-B'

DEPARTMENT OF NATURAL RESOURCES
FLORIDA GEOLOGICAL SURVEY

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