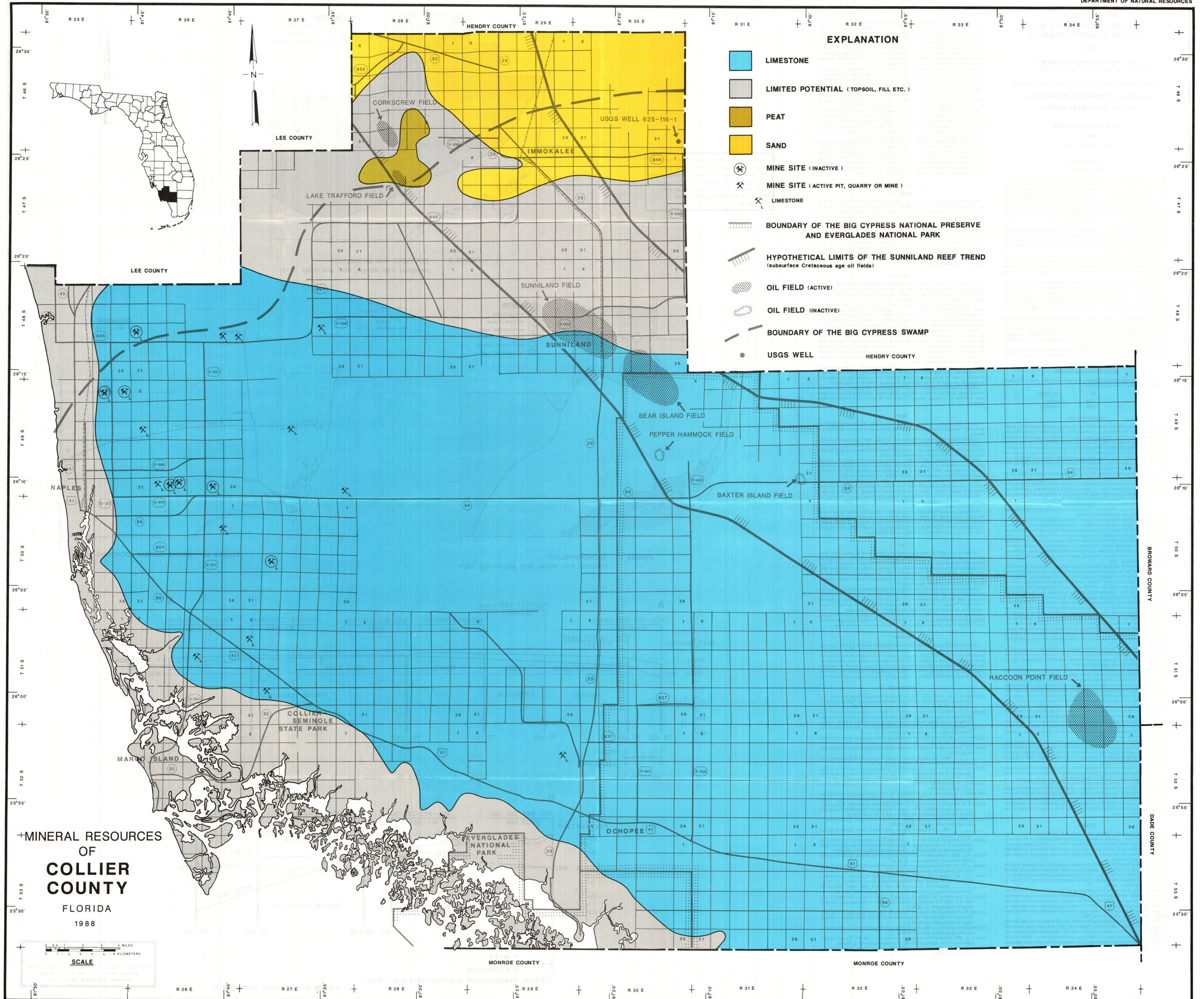




MAP SERIES NO. 120
MINERAL RESOURCES OF
COLLIER COUNTY, FLORIDA

BY

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COLLIER COUNTY

INTRODUCTION

In recent years, considerable attention has been focused on Florida's rapid development, accompanying population increase and their effect on the state's important mineral resources. Frequently, urban development has occurred in areas underlain by known mineral deposits, which precludes future extraction of the minerals. 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 legislation enacted by the Florida Legislature in 1965 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 Collier County Commissioners, the Florida Geological Survey initiated a study of Collier County's mineral resources. The objective of this report is to 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 city and county planners.

A knowledge of Collier 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 analysis 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, a necessary precursor to mining in order to determine reserves, content and extent of specific mineral resources. In addition, such factors as operating expenses, 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, county, 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 to 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

GEOMORPHOLOGY

McCoy (1962), White (1970) and Healy (1975) are the primary sources used for the following discussion of the geomorphology of Collier County. McCoy (1962) accepted the geomorphic designations of Davis (1943) and divided the county into four geomorphic regions: the Flatlands, the Big Cypress Swamp, the Southwest Coast, and the Ten Thousand Islands. White (1970) subdivided Florida into three geomorphic zones and designated the southern portion of the peninsula as the Southern or Distal zone. The Southern zone is divided into a number of geomorphic regions and the following areas of this zone occur in Collier County: Immaculate Rise, Big Cypress Spur, Southwestern Slope, Reticulate Coastal Swamps, Gulf Coastal Lagoons, and Ten Thousand Islands (Figure 1).

The Immaculate Rise, which includes the Flatlands as described by McCoy (1962), occurs in the northern portion of Collier County. The part of the Immaculate Rise found in Collier County (Figure 1) is the southernmost extension of a submarine shelf formed by the Pamlico silt (White, 1970). The Immaculate Rise is composed of quartz sand overlying older limestone. The surface elevations of this feature range between 25 and 40 feet above mean sea level (MSL). The area has shallow depressions containing water, marshes and swamps. The vegetation in the region consists of pine and cypress trees, palmettos, shrubs, grasses, and sub-tropical plants (Leighly et al., 1954). Most of the drainage from the area is through Corkscrew Swamp, Lake Trafford and Okaloosatchee Slough.

Big Cypress Spur (White, 1970) contains a portion of the Big Cypress Swamp area of McCoy (1962). As shown in Figure 1, the Big Cypress Spur is a triangular-shaped area on the eastern side of Collier County. The region is characterized by exposed limestone, thin, sandy, mucky soils, and peat overlying limestone. The surface elevations in the area range from seven feet MSL in the south to 18 feet MSL along the northern edge of Collier County. Drainage is to the south. As the name implies, Big Cypress is predominantly a swampy area containing numerous cypress trees. However, within this area where the land surface is sufficiently high and drained, the soils support hammocks, pine islands, shrubs, grasses, palmettos, and cypress (Leighly et al., 1954).

The remaining portion of McCoy's (1962) Big Cypress Swamp is included in White's (1970) Southwestern Slope. The Southwestern Slope is bordered on the east by the Big Cypress Spur to the northeast by the Immaculate Rise and to the west and southwest by the Reticulate Coastal Swamps. The Southwestern Slope is covered by sandy soils overlying limestone. Elevations in the area range from two feet MSL at the southern boundary with the coastal swamps up to 25 feet MSL, where the Slope joins the Immaculate Rise. Vegetation in the area consists of cypress and pine trees, grasses, shrubs, and palmettos (Leighly et al., 1954). Because of the flatness of the Southwestern Slope, drainage into the Gulf of Mexico is sluggish. The main drainage outlets on the Slope are the Okaloosatchee Slough, Deep Lake Strand, and Lakatchee Strand. This area is drained by an extensive system of canals that transports water southwest into the coastal swamps and lagoons of the Gulf of Mexico.

Asphy named, the Reticulate Coastal Swamps of White (1970), are intricately channelled coastal marshes and mangrove swamps that form the southwest coastline of Collier County. Because they are less than five feet above mean sea level, these lowlands are subject to tidal action. They consist of thin organic and marly soils overlying limestone of the Tamiama Formation.

Separating the mainland's Reticulate Coastal Swamps from the Ten Thousand Islands are the Gulf Coastal Lagoons. Although some of the more expansive lagoons of this geomorphic region are up to a mile wide, most are one-half mile or less. They are very shallow and have many shoals that are exposed at low tide.

Ten Thousand Islands is a name that describes the unique group of islands that stretches approximately 25 miles southeastward from Cape Romano in Collier County to Pelican Key in Monroe County. According to Shier (1969), the cores of most of the outer, Gulfward islands are large reefs that were built by colonial marine gastropods, having long, tube-like shells called vermetids. The inner islands are long, intricately twisted and channelled oyster bars. Both island types have surface elevations of five feet or less and are covered by mangroves, which trap sand, silt, and organic sediments. Limestone of the Tamiama Formation is the bedrock upon which the reefs have grown. The limestone forms a shelf that slopes gently from the coastline towards the Gulf of Mexico. The shelf lies about eight feet below sea level under the inner islands and as deep as 20 feet beneath the outer islands.

Deposits of Pleistocene age quartz sand occur as a thin mantle over much of southern Collier County, on some of the Ten Thousand Islands, and as dunes on Marco Island. These sands are unconsolidated, white to gray, with organic material and occasional shells, indicating a marine origin (Parker and Cooke, 1984).

Some of the highest elevations in south Florida, up to 52 feet, occur on a spectacular, elliptical dune system on southeastern Marco Island, Marco Island, Cape Romano and its associated shoals, and the sandy beaches of some of the Ten Thousand Islands mark the southern limit of significant deposits of quartz sand on Florida's west coast. Very little quartz sand occurs south of Collier County.

Superimposed on the present geomorphology of the county are three reflect marine terraces reflecting higher sea level stands during the Pleistocene Epoch. Erosional and depositional processes associated with the former sea level highs carved the modern topography out of the older geologic formations, largely determining the modern distribution of surficial sediments. Healy (1975), on the basis of elevation, recognized three marine terrace levels in Collier County (Figure 2). The boundaries of the Talbot, Pamlico and Silver Bluff Terraces reflect possible positions of the paleoshoreline corresponding to each sea level high-stand.

McCoy (1962) recognized the Pamlico shoreline on aerial photographs and topographic maps. He also stated that a remnant of the higher Talbot Terrace, called Immaculate Island, occurs in the county (Figure 2).

GEOLOGY

McCoy (1962) and Lane (1980, 1981) are primary sources for the following summary of the geology of Collier County. Igneous basement rocks have been identified in oil test wells at depths greater than 18,000 feet below land surface in Collier County (Applegate and Lloyd, 1969). Overlying these rocks is a thick section of younger carbonates (limestone and dolomite) that is in turn overlain near the surface by siliciclastic sediments composed of sand, clay, sandy limestone and dolomite.

The Late Pliocene Tamiama Formation is the oldest stratigraphic unit exposed in Collier County. The lithology of the Tamiama ranges from a sandy limestone and sandy dolomite to soft, sandy calcilutite. This formation, which was deposited approximately three to four million years ago, underlies the majority of Collier County (Figures 3b and 3c). It can be more than 100 feet thick in places.

Throughout much of the county, the upper part of the Tamiama Formation is a relatively thin, highly permeable, fossiliferous limestone. This limestone unit, which attains a thickness of approximately 32 feet east of Immokalee at the Hendry County line, thin to the west (United States Geological Survey well 625-1161 located approximately nine miles east of Immokalee, Mineral Resources Map). These highly permeable sediments form the principal shallow aquifer in Collier County (McCoy, 1962).

The Pleistocene Epoch Caloosahatchee Formation unconformably overlies the Tamiama Formation in northeastern Collier County. Parker et al. (1955) described these sediments as predominantly gray-green, silty, sandy shell marl with interbedded layers of sand, silt, clay, and marl. Variable in thickness, this Pleistocene unit has a thickness of 18 feet in USGS well 625-1161. The relatively low permeability of the Caloosahatchee sediments precludes its use as a major source of water.

Overlying the Tamiama Formation in northern and eastern Collier County is the Fort Thompson Formation which was also deposited during the Pleistocene Epoch (Figure 3b). This unit contains alternating beds of freshwater and marine shell marls which contain sands, shell hash and sandy fossiliferous limestones. The Fort Thompson Formation pinches out to the west and south in Collier County. Well data indicate that the Fort Thompson Formation ranges in thickness from three to nine feet along the eastern boundary of the county (Schroeder and Klein, 1964). The Fort Thompson Formation is overlain by the younger Miami Limestone (Hoffmeister et al., 1967) in southeastern Collier County and by undifferentiated sands and clays in the remainder of eastern Collier County.

The Miami Limestone unconformably overlies the Ft. Thompson Formation in the southeast corner of Collier County. The contact between these two units can be observed along canal banks in Collier County just west of the Dade County boundary. The Miami Limestone is a sandy, nearly pure limestone. Further south and east in the Everglades it occurs as an oolitic limestone composed primarily of ooids (tiny spherical grains of calcium carbonate). The Miami Limestone attains a maximum thickness of less than 10 feet in the county (Lane, 1981). Although this unit thickens to the east in Dade County, where it forms an integral part of the Biscayne Aquifer System, it pinches out in eastern Collier County. The majority of Collier County's surface is covered by terrace sands laid down during past fluctuations of sea level and are referred to in the cross sections as "Undifferentiated Sand, Clay and Shell Beds" (Figures 3b and 3c). Varying in thickness throughout the county, these quartz sands exceed 60 feet in thickness near the town of Immokalee in northern Collier County. In this area these sediments form a locally important shallow aquifer system which yields water to many shallow sandpoint wells (McCoy, 1962).

In addition, marine sediments that vary from sandy limestone to shelly, sandy marl, occur in a band approximately five to six miles wide paralleling the west coast of Collier County. These sediments, which are also referred to in this report as "Undifferentiated Sand, Clay and Shell Beds", unconformably overlie the Tamiama Formation (Figures 3b and 3c). These deposits can be observed along the canal banks on the north side of State Highway 846. Carbonates present in this unit are generally permeable and in the vicinity of Naples, where they thicken, form part of the surficial aquifer system (McCoy, 1962).

MINERAL RESOURCES

Introduction

The purpose of the following discussion is to provide information on the occurrence of certain mineral commodities in Collier County. The information presented is not intended to be an exhaustive investigation leading to immediate industrial development. However, where the information is favorable it may indicate that certain areas might warrant further investigation. The Mineral Resources Map is designed to present a geographic overview of the major mineral commodities identified in Collier County. Factors such as thickness of overburden, quality, and volume of the deposit could affect the mining of the mineral commodity at any specific site. In contrast, geologic cross sections have been extrapolated from cores and/or well cuttings to show the distribution and thickness of surface and near surface stratigraphic units (Figures 3b and 3c). As a result, occasional variations between the geologic cross sections and the Mineral Resources Map may occur. The principal mineral commodities occurring in Collier County are limestone, sand and peat. In addition, a brief discussion of petroleum is included.

Limestone

In Collier County limestone of economic value is extracted from the Pliocene age Tamiama Formation (Schmidt et al., 1979). The Tamiama is comprised of tan to white or gray, poorly to well indurated, sandy, mottled, shelly limestone. Preservation of the limestone varies depending on the amount of recrystallization (Weeder, 1979).

The Tamiama Formation is mined primarily in western Collier County. Eight of the approximately 10 major producers in the county are located west of the north-south oriented Everglades Boulevard, where both transportation routes and commercial developments are most numerous. A large percentage of eastern Collier County is included in the Big Cypress National Preserve which may preclude this area's consideration for mineral extraction.

The open pit mining method is used exclusively by companies extracting limestone in the county. Prior to mining, bulldozers clear away overburden which normally averages less than five feet in thickness. The overburden material is used as a source of local fill. After the limestone surface is cleared of overburden, the limestone is fractured by either blasting or heavy machines. The broken rock is loaded by dragline or front-end loader into trucks and transported to rock crushers for processing. Frequently, mining occurs underwater by draglines to depths approaching 50 feet.

The Tamiama limestone mined in Collier County is primarily used to produce base rock for roadways and as an aggregate grade rock for concrete and asphalt. Additionally, crushed limestone is used for riprap, and drainfields. The fines, which remain after the production of aggregate, are used as a filler material in bituminous mixes for road surfaces.

Local mine operators report that at present mining rates they can operate for approximately 30 more years. According to county records over 100 million cubic yards of limestone have been permitted for extraction. However, to date only 23 million cubic yards have been extracted.

Sand

Quartz sand occurs as a veneer over most of Collier County (Figures 3b and 3c) (Scott et al., 1980). However, in the Immaculate Rise area thicknesses of as much as 60 feet are present.

A narrow (approximately three miles wide) strip of clayey, shelly sand is present along Collier County's west coast. These sediments extend from the Lee County Collier County line south to Gordon Pass. The siliciclastic sediments, which attain thicknesses of up to 10 feet, are occasionally cemented to form sandstones (Lane, 1980).

Mining in Collier County is predominantly limited to limestone. The overburden material in the area is essentially quartz sand and is utilized as a source of local fill (Campbell, 1986). Operators report that other uses include "clean" fill, as fill for mound system septic tank drainfields, and in asphalt and concrete mixtures.

The Soil Survey of Collier County (Leighly et al., 1954) indicates that the Pompano and Charlotte soils are good sources for sand. The Pompano-Charlotte soil association occurs primarily in western Collier County.

The ratings of the Soil Survey are primarily based on thickness, texture and amount of organic material in the sediment. This local survey sampled soils to a depth of 80 inches (land surface).

Potential for sand as a mineable resource is greatest in northern and western Collier County (Mineral Resources Map). The influx of people settling along the west coast of Florida will certainly increase demand for this resource thereby enhancing the future prospects of sand as a principal commodity. However, with the majority of the population living along the west coast, sand as a potential resource in this area is diminishing.

Peat

The presence of peat has been documented in Collier County for years. Davis (1948) estimated that 15 square miles of peatlands is present in the county. Major peatland areas include the Corkscrew Marsh in the vicinity of Lake Trafford, scattered locations in the Big Cypress National Preserve, and coastal marshes and swamps (Griffin et al., 1982). Lane (1980, 1981) mapped the Ten Thousand Island area of Collier County as being primarily peat. In addition, Griffin et al. (1982) mapped quantities of fuel grade peat in Collier County. However, he did not define the limits of these deposits.

A peat deposit occurs when the accumulation of organic materials exceeds the decomposition rate of dead vegetation. In order to mine peat at a particular site the surface vegetation is cleared away and the area drained. The actual mining is accomplished by draglines or bulldozers. The peat is then shredded and stockpiled to dry (Bond et al., 1986). The peat material may be mixed to specifications upon request from the consumer.

Although enormous quantities of peat do exist in Collier County and they could be used for horticulture and possibly fuel, none is presently mined. Future mining of peat is doubtful as a result of peat deposits being located in environmentally sensitive areas.

Petroleum

A total of 80,809,071 stock tank barrels of oil and 6,880,971 million cubic feet of gas has been produced from sediments underlying Collier County in the period from 1943 to 1986 (Applegate and Lloyd, 1969). This oil and gas is produced from seven fields that are located either entirely or partially on Collier County (Mineral Resources Map). The production occurs from wells drilled into sediments that underlie Collier County at a depth of more than 11,000 feet below land surface. Present production is expected to decline in the foreseeable future. However, exploration continues in the region in hopes of making new discoveries.

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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 abbreviation, the Township, Range, and Section, and the quarter/quarter location within the section.

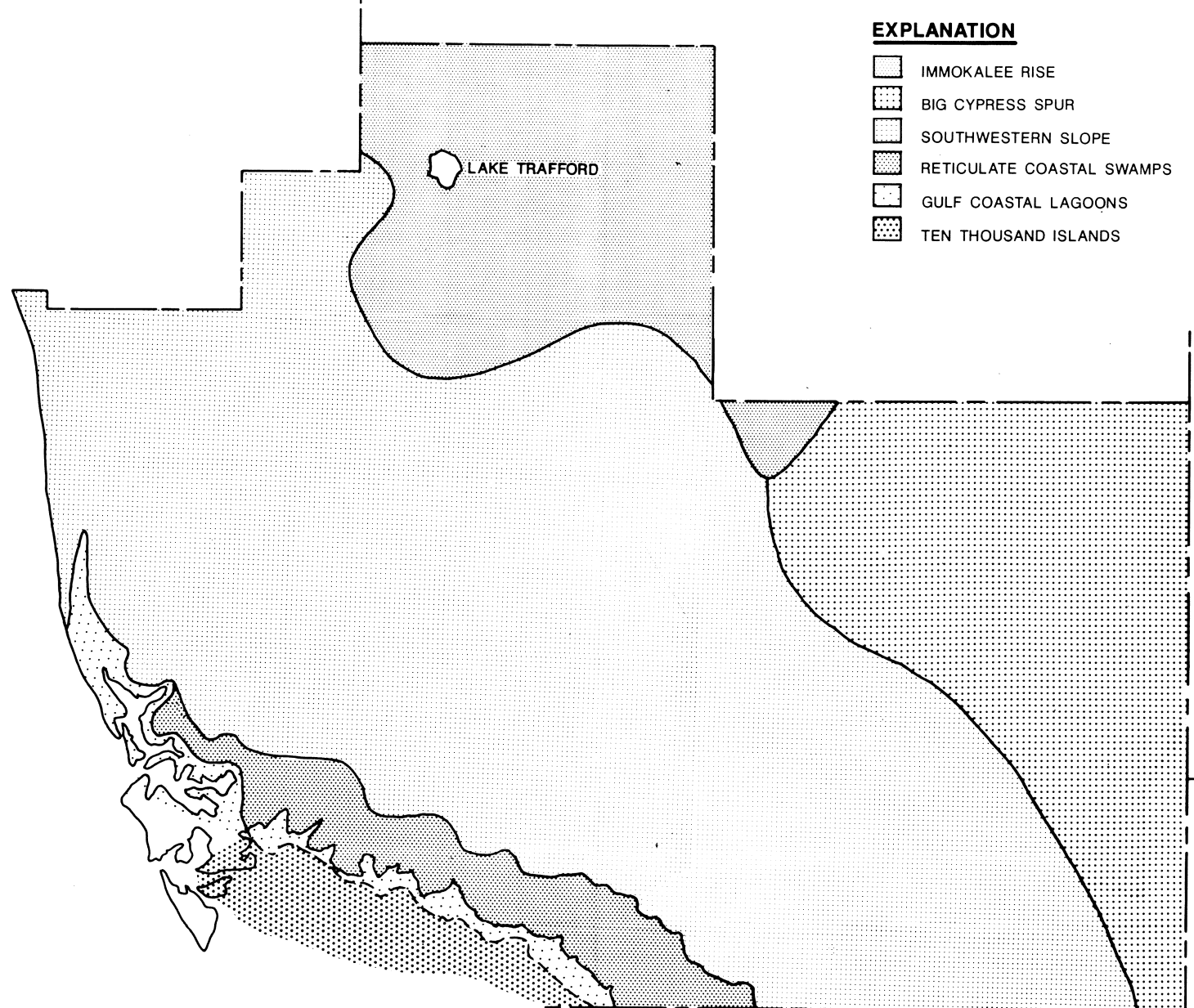
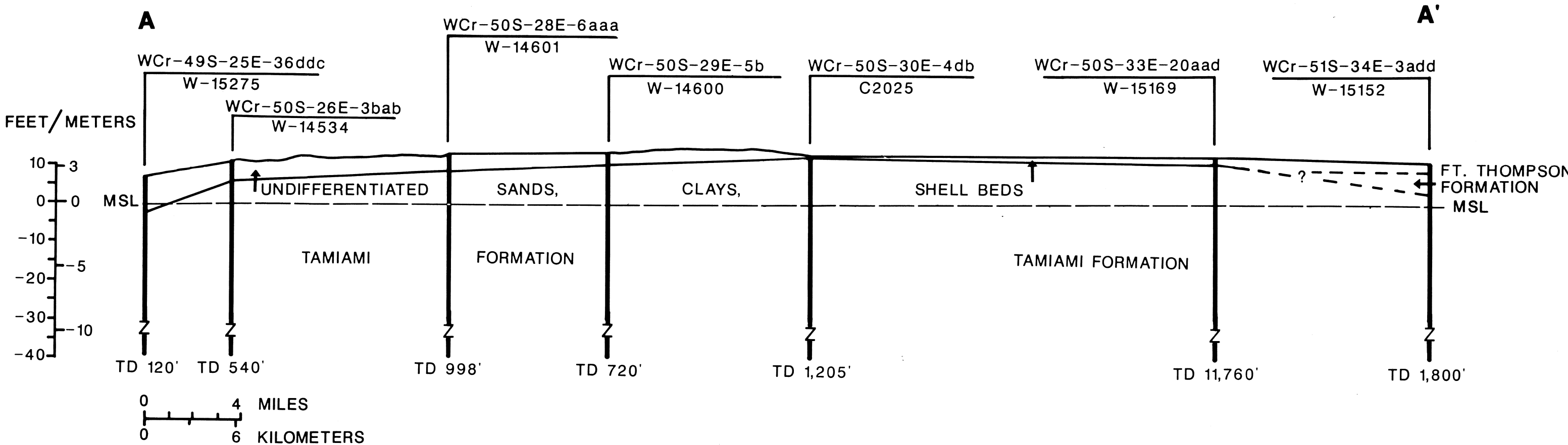
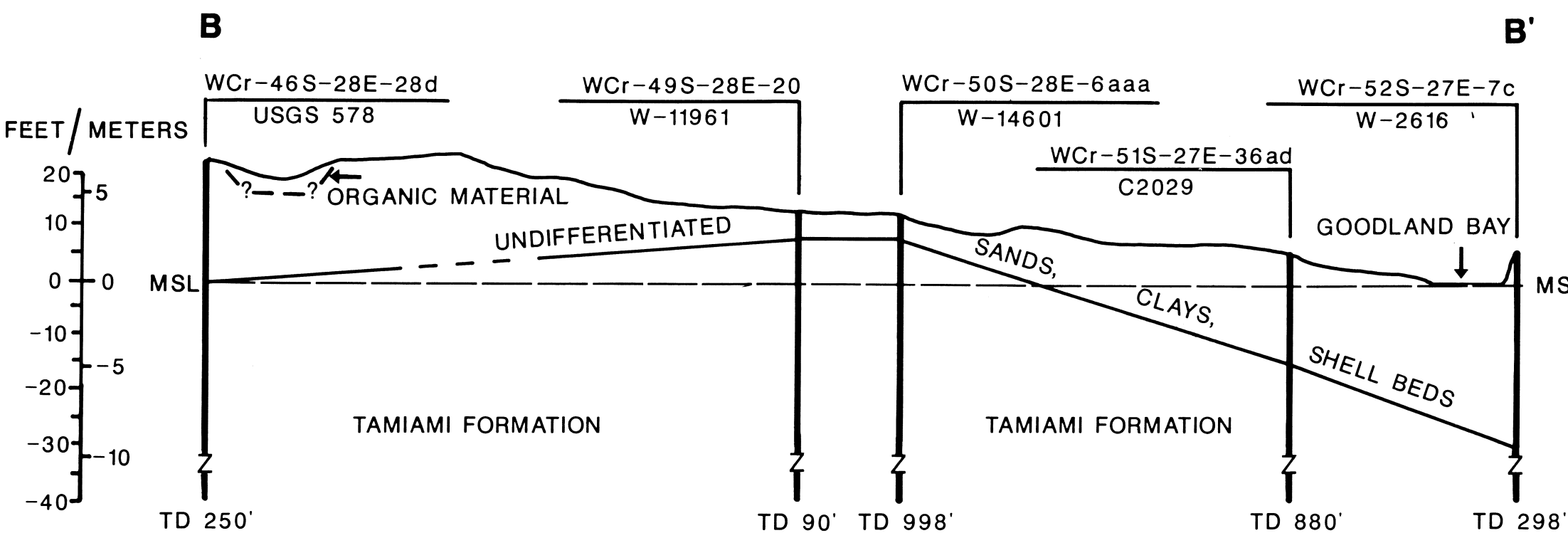


FIGURE 1 GEOMORPHOLOGY
(modified from White, 1970 and Vernon, 1951)



VERTICAL EXAGGERATION IS APPROXIMATELY 845 TIMES.



VERTICAL EXAGGERATION IS APPROXIMATELY 845 TIMES.

FIGURE 3c CROSS SECTION B-B'

EXPLANATION
25-42 TALBOT TERRACE
8-25 PAMLIKO TERRACE
0-10 SILVER BLUFF TERRACE

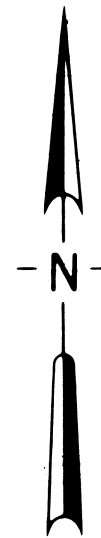


FIGURE 2 TERRACES AND SHORELINES
(modified from Vernon, 1951 and Healy, 1975)

EXPLANATION

IMMOKALEE RISE
BIG CYPRESS SPUR
SOUTHWESTERN SLOPE
RETICULATE COASTAL SWAMPS
GULF COASTAL LAAGONS
TEN THOUSAND ISLANDS

SCALE
0 4 MILES
0 6 KILOMETERS
FOR FIGURES 1, 2, 3a

EXPLANATION

WELL LOCATION

FIGURE 3a CROSS SECTION LOCATIONS

DEPARTMENT OF NATURAL RESOURCES
FLORIDA GEOLOGICAL SURVEY
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