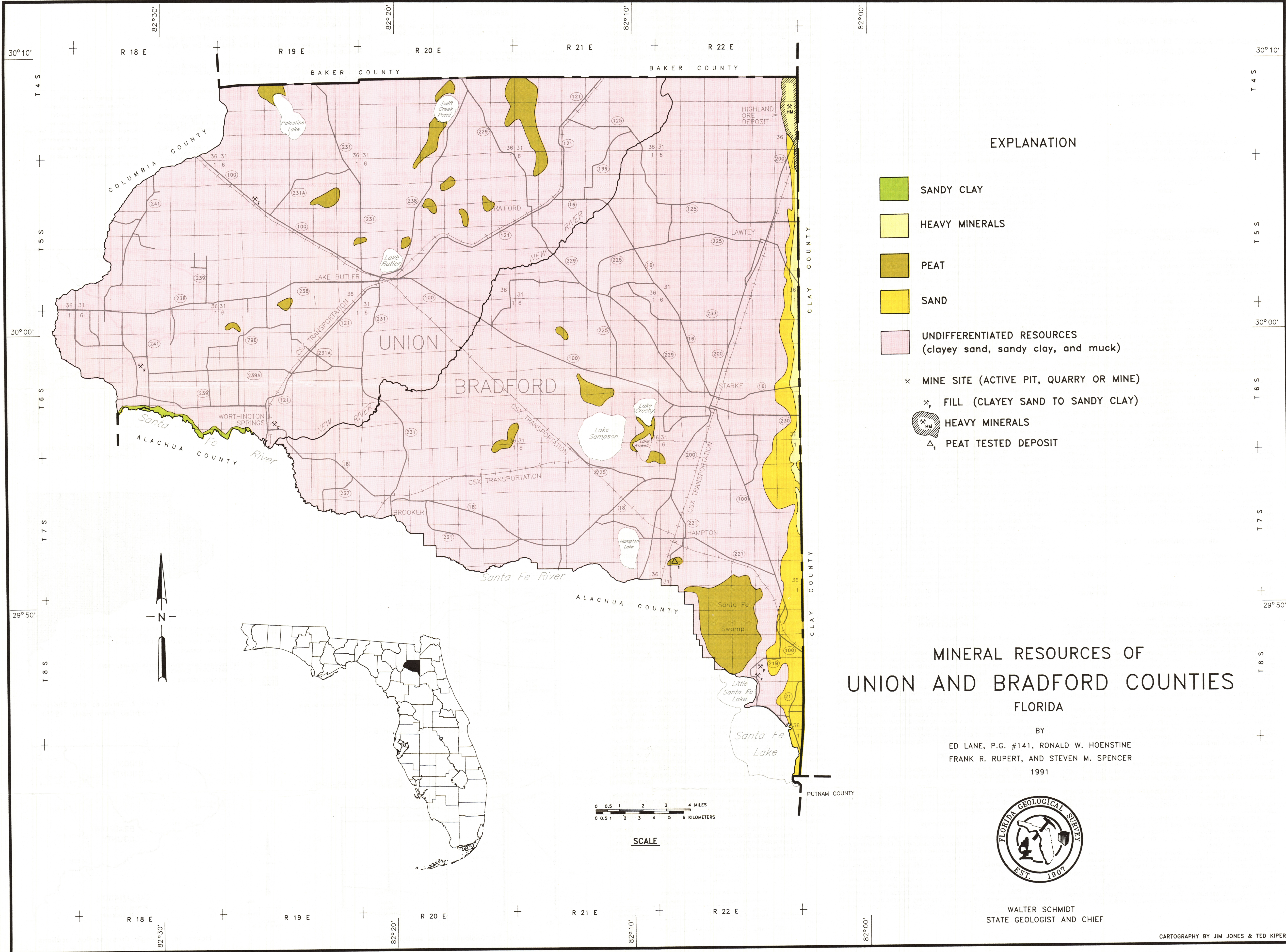




MAP SERIES NO. 134

MINERAL RESOURCES OF UNION AND BRADFORD COUNTIES, FLORIDA

By

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UNION AND BRADFORD COUNTIES
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, precluding future extraction of the minerals. The economics associated with these mineral resources represent substantial employment and income to the private sector as well as revenue 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 North Central Florida Regional Planning Council, the Florida Geological Survey initiated a study of Union and Bradford Counties' mineral resources. The objective of this report is to summarize and interpret geologic data (i.e., core and well cutting descriptions and geophysical logs, and data derived from field reconnaissance) in a format appropriate for use by city and county planners.

A knowledge of an area's mineral resources is basic and integral to the process of initiating, developing and implementing an effective comprehensive land use plan. The information and data are essential to planners and officials in their analysis of urban and rural development in matters of zoning, road construction and the establishment of waste disposal sites.

Factors used in evaluating the economic value of the counties' 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, 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, beneficiation, transportation, 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, and numerous discussions with state and federal officials. 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 duplication of English and metric units in this report, the following conversion factors are provided:

MULTIPLY	BY	TO OBTAIN
	0.3048	meters
feet	1.609	kilometers
miles		

GEOMORPHOLOGY

Situated in north-central Florida, Union and Bradford Counties fall entirely within the Northern (Proximal) Zone of White (1970). This zone encompasses all of the Florida panhandle and the northern Florida peninsula southward to an approximate line connecting the cities of St. Augustine, Palatka, Gainesville and Perry.

Within the Northern Zone the major geomorphic feature is the Northern Highlands. This prominent feature, which covers all of Union and Bradford Counties (Figure 1), extends across the northern part of Florida from the Trail Ridge on the east to the state's western boundary (White, 1970; Puri and Vernon, 1964). Elevations within the study area range from less than 50 feet above mean sea level (MSL) along the Santa Fe River in the south to over 200 feet on parts of Trail Ridge in northeast Bradford County (Figures 1 and 2).

Union County has a diversity of surface features, including numerous hills, valleys, broad low areas, streams, and rivers. Navigable waters include Olustee Creek and the Santa Fe River, forming the western and southern county boundaries, and New River which forms the Union-Bradford County boundary. In the general area of Worthington Springs, distinctive bluffs more than 50-feet high border the Santa Fe River's flood plain.

Trail Ridge is a major feature situated in the eastern part of Bradford County (Figure 1). Trail Ridge has been thought to be a beach-complex deposit, however, a more recent study by Force and Garner (1985) suggests a sand-dune origin. Relatively rapid increases in elevation occur as one goes onto the ridge from west-to-east, from approximately 170 feet at the toe of the ridge to over 215 feet along the eastern Bradford County line (Figure 2). Maximum ridge elevations occur in neighboring Clay County east of Lawtey, where the ridge crests at slightly over 220 feet above MSL.

The counties have a number of relatively shallow lakes, the largest of which are shown on Figures 1 and 2. Typically, these lakes have low, swampy shorelines with sand or mud bottoms; all have outflow channels which are tributaries to Olustee Creek, the New River, or the Santa Fe River (Clark et al., 1964).

Pleistocene sea level fluctuations have significantly influenced the surface topography of Union and Bradford Counties. These ancient sea level high stands formed step-like terraces. Healy (1975) recognized four terraces based on elevation as being present in Union and Bradford Counties (Figure 2). They are, from oldest to youngest (and highest to lowest), the Hazlehurst Terrace (215 - 320 feet above MSL), the Coharie Terrace (170 - 215 feet above MSL), the Sunderland/Okfeenokee Terrace (100 - 170 feet above MSL) and the Wicomico Terrace (70 - 100 feet above MSL).

GEOLOGY

The study area is underlain by Paleozoic basement rocks at depths of approximately 3,000 feet below land surface (2,800 feet below MSL). To date, the deepest penetration of sediments in Union County occurred in an oil test well, W-11912 (section 31, Township 4S, Range 19E), drilled in 1973 to a depth of 2,917 feet below MSL. Fifteen feet of Paleozoic basement rocks were first encountered at a depth of 2,902 feet below MSL (Barnett, 1975; Lloyd, 1985). The deepest well drilled in Bradford County is oil test well W-1466 (section 15, Township 6S, Range 20E), drilled in 1947 to 3,035 feet below MSL. At a depth of 3,008 feet below MSL this well then penetrated 27 feet of Paleozoic basement rocks, composed of quartzitic sandstone and shale (Lloyd, 1985). These basement rocks are overlain by thousands of feet of Mesozoic and Cenozoic age carbonates (limestone and dolomite), which dominate the area's stratigraphic column (Florida Geological Survey well data). In the near-surface, the lithology changes to predominantly siliciclastic sediments consisting of hundreds of feet of marine sands and clays, with interbedded limestones and dolomites (Clark et al., 1964). Figure 3a is a map showing geologic cross section locations used in this report. Figures 3b, 3c, and 3d are west-east and north-south geologic cross sections showing the near-surface sediments of Union and Bradford Counties.

The oldest rock penetrated by water wells in the area is the Avon Park Formation, which was deposited approximately 49 to 41 million years before present (B.P.) during the Middle Eocene Epoch. This formation and the younger overlying limestone units are an integral part of the Floridan aquifer system, the primary source of fresh water in the counties. Typically, the Avon Park Formation occurs as a dense, tan to dark brown, porous dolomite, frequently interbedded with tan, gray or cream-colored limestone and dolomitic limestones of varying hardness (Clark et al., 1964). It underlies the area at depths ranging from 260 to 460 feet below MSL (Florida Geological Survey well data).

The Ocala Group limestones unconformably overlie the Avon Park Formation throughout the area. These rocks, which in this report are referred to as the Ocala Group undifferentiated, were deposited during the Late Eocene Epoch (approximately 41 to 38 million years B.P.). The lithology of the Ocala Group varies from white to tan, marine fossiliferous limestone and dolomitic limestone, to white to pale orange, abundantly fossiliferous, chalky limestones (Clark et al., 1964). In Union County, the Ocala Group averages approximately 250 feet in thickness. The top of the Ocala Group is encountered at depths ranging from approximately 20 feet above MSL in the floodplain of the Santa Fe River in southwestern Union County to nearly 190 feet below MSL in W-524 (section 16, Township 5S, Range 21E) in northeastern Union County. In Bradford County, the top of the Ocala occurs at depths that range from 26 feet below MSL in W-5180 (section 32, Township 7S, Range 21E) to 292 feet below MSL in W-12360 (section 25, Township 4S, Range 22E) (Figures 3a, 3b, 3c, and 3d). Thickness ranges from about 200 to 250 feet in Bradford County (Clark et al., 1964).

The Suwannee Limestone of Oligocene age (38 to 33 million years B.P.) unconformably overlies the Ocala Group in sporadic occurrences in western Union County and southwestern Bradford County (Clark et al., 1964). The lithology of this formation is commonly a tan, white, or cream-colored marine limestone, frequently dolomitic and coquina in portions and varying in hardness. The top of the Suwannee Limestone occurs at a depth of 38 feet above MSL in W-4533 (section 6, Township 6S, Range 18E), and varies in thickness from 10 to 40 feet. Where present, this formation is also part of the Floridan aquifer system.

Phosphatic sands, clays, limestones and dolomites comprising the Early and Middle Miocene (23 to 15 million years B.P.) Hawthorn Group unconformably overlie the Suwannee Limestone in its area of occurrence. In those portions of Union and Bradford Counties where the Suwannee Limestone is missing, the Hawthorn Group unconformably overlies the Ocala Group. These sediments, which are referred to as Hawthorn Group undifferentiated in the cross sections, have variable and interbedded lithologies characterized by phosphatic sands, granules and pebbles. This unit has a generally northeastward dip in this area and ranges in thickness from approximately 40 feet in parts of western Union County to over 260 feet in the northeastern portion of the county near Raiford. In Bradford County, the Hawthorn Group ranges in thickness from less than 100 feet in the southwest to over 310 feet in the northeast (Florida Geological Survey well data).

Thick, relatively impermeable clays and clayey sands, present in the Hawthorn Group, serve as a confining unit for the underlying Floridan aquifer system. In contrast, quartz sand and carbonate units within the Hawthorn Group are water-bearing and form part of the intermediate aquifer system in the two county region (Hoenstine et al., 1989).

Undifferentiated quartz sands and clays unconformably overlie the Hawthorn Group. These sediments form a veneer over the majority of Union and Bradford Counties. This unit includes the unnamed reddish, coarse siliciclastics, the relict Pleistocene Series (1.8 million to 10,000 years ago) marine terrace sands, and Holocene (10,000 years ago to present) aeolian, lacustrine and alluvial deposits. Sediments within this unit and in the thin limestone layers in the uppermost Hawthorn Group contain the surficial aquifer system in Union and Bradford Counties.

MINERAL RESOURCES
INTRODUCTION

The purpose of the following discussion is to provide information on the occurrence of certain economic mineral commodities in Union and Bradford Counties. The information presented is not intended to be an exhaustive investigation leading to immediate industrial development. However, favorable information may indicate that certain areas warrant further investigation. The Mineral Resources Map is designed to present a geographic overview of the major economic mineral commodities identified in the area. 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, 3c, and 3d). As a result, occasional variations between the geologic cross sections and the Mineral Resources Map may occur. The following is a discussion of the clay, heavy minerals, limestone, peat, phosphate, sand and the undifferentiated resources of the study area.

Clay

Bell (1924) studied the economic clay reserves of northern peninsular Florida. He concluded that sandy clays are present in Union and Bradford Counties, however, the clay was not considered suitable for commercial use. These sandy clays include floodplain deposits present along the Santa Fe River (Mineral Resources Map). Subsequent surveys by the U. S. Soil Conservation Service (SCS) (1989a; 1989b) as well as field work for this report support these early findings.

Heavy Minerals

Quartz sand containing a very small fraction of heavy minerals occurs over most of Florida. A small area of northeastern Bradford County near the town of Highland, Florida is known to have heavy minerals in a quantity substantial enough to be considered for commercial production (personal communication, U. S. Bureau of Mines). The Highland ore deposit (Pirkle et al., 1977) is present in northeastern Bradford, Clay, Baker and Duval Counties. The deposit averages about three percent heavy minerals of which approximately 45 percent are titanium-bearing minerals. Pirkle et al. (1977) report the titanium dioxide (TiO₂) content of those minerals is about 69 percent. The heavy minerals associated with this deposit include ilmenite, leucocene, staurolite, zircon, kyanite, sillimanite and tourmaline (Pirkle et al., 1977).

E. I. duPont de Nemours Company leases much of the Highland ore deposit area as well as mineable deposits along the Trail Ridge which are mined in neighboring Clay County. Company statistics are held in strict confidentiality; therefore, the value and production criteria are unavailable. A study by Tyrrell and Klinefelter (1956) concluded that heavy-mineral processing tailings may be used as ceramic raw material. The heavy-mineral sands of the region continue to hold promise for future economic development.

Limestone

Limestone occurs at depths of 40 feet or more below land surface throughout the two counties (Figures 3b, 3c, 3d). Figure 3c shows the top of the Ocala Group rises to within 40 feet of land surface. Overlying sediments along the river consist of sandy clays, clayey sands, and clays (see Mineral Resources Map). Limestone outcrops sporadically in the river channel.

Limestone mining has never occurred in either Union or Bradford Counties. Due to the proximity of limestone deposits to the Santa Fe River, mining would warrant major environmental considerations. However, in neighboring Alachua County, Ocala Group limestone is mined extensively. These nearby locations of commercial grade limestone deposits lessen the probability of mining the Union County limestone deposits in the near-future.

Peat

Peat is an accumulation of partially decomposed plant remains which accumulates in perennially wet areas (Davis, 1946; Bond et al., 1986). Along with wet conditions, other factors such as climate and topography play an important role in the formation of this material. Union and Bradford Counties have areas of potential peat accumulation. These areas are located primarily in the northern region of Union County near Palestine Lake, Swift Creek Pond, and Turkey Creek Swamp. In Bradford County the areas are clustered around the Lake Sampson region, in the Santa Fe Swamp, and near Hampton where Davis (1946) analyzed peat material (Table 1).

The U. S. Soil Conservation Service (1989a; 1989b) designated those areas mentioned above along with numerous smaller areas as highly organic soils (Mineral Resources Map). Dorovan muck is the primary organic soil type in these areas and attains a known thickness of at least 80-inches (the maximum depth interval sampled by the Soil Conservation Service). Much of the Santa Fe Swamp, in southeastern Bradford County (see Mineral Resources Map), contains Dorovan muck (SCS, 1989b). Georgia-Pacific Corporation has investigated this area relative to using the organic material as a potential energy source. However, it is presently under the jurisdiction of the Suwannee River Water Management District, which probably precludes its exploitation.

Peat is not presently mined in Union or Bradford Counties. However, in nearby Putnam County peat is mined and used for horticultural purposes.

Phosphate

Florida and North Carolina provide over 75 percent of the phosphate produced in the United States and greater than 25 percent of the world's phosphate production (Florida Phosphate Council, 1980). The phosphate mined in Florida is from the Miocene Hawthorn Group. Although sediments of the Hawthorn Group are present in Union and Bradford Counties, their phosphate content is not as high as other areas of Florida.

Analyses conducted by the U.S. Bureau of Mines on Hawthorn Group sediments in three wells in Bradford County showed average P₂O₅ contents of 3.5 percent (Davis et al., 1983). In a report prepared for the U. S. Bureau of Mines, Zellars and Williams, Inc. (1978) defined the limits of the North Florida Phosphate District and included nearly all of Union and Bradford Counties. They characterized the district as follows:

Thickness of overburden	20-50 ft.
Thickness of ore zone	10-25 ft.
Pebble percent of product	10-20
Percent Bone Phosphate Lime (BPL)	66-70
Percent MgO	0.75
Percent U ₂ O ₈ of product	0.008
Percent F	3.0-4.0

With the exception of Hamilton County, the characteristics of this district, especially pebble percent and BPL content, are not sufficient to compete economically with deposits located farther south in the peninsula. These unfavorable economic factors probably preclude the mining of phosphate here in the near future.

Sand

Quartz sand is present over most of Bradford and Union Counties. However, there are no commercial sand mining operations within the boundaries of Union and Bradford Counties. Nearby, in western Clay County, along the Trail Ridge, deposits of quartz sand and heavy-mineral sand have been mined for many years (Spencer et al., in preparation).

An area along the Trail Ridge offers the greatest potential for commercial sand mining in this two-county region. In this part of Trail Ridge in Bradford County, elevations rise to 200 feet above MSL. The authors defined the sand resource area to include elevations down to the 170 foot contour. This area is considered to afford the best potential as a sand resource, based on elevation and knowledge of mining activities along the Trail Ridge (past and present).

Undifferentiated Resources

Much of Union and Bradford Counties have surface and near-surface sediments comprised of undifferentiated clayey sand and sandy clay. Many low-lying, perennially wet areas have sandy or clayey soils with high percentages of decomposed organic matter, often called "muck." The potential for large scale economic utilization is diminished by the heterogeneous nature of these sediments. However, they are locally valuable as fill, and have use as top soil.

The Florida General Soils Atlas (Kolb, 1974) presents information on soil potential and uses a rating system which implies predictable material performance. Several areas are rated as "good" source areas of road fill material. A good rating for road fill means the sediment will remain intact after proper compaction and drainage are incorporated, and the soil is easily excavated. The Interim Soil Surveys for Union County (SCS, 1989a) and Bradford County (SCS, 1989b) list several soils as probable sources of construction sand. Although these probable sand source areas are scattered over the two-county region, the authors believe the Trail Ridge to be the best sand resource area, based on field reconnaissance. Along the sand resource area of the Trail Ridge (down to the 170 foot contour) the SCS identifies the primary soil types as Leon, Allanton and Pottsburg fine sands.

The Union County Road Department currently operates three borrow pits for fill material and Bradford County maintains two borrow pits. Clayey sand extracted from these pits is used as a road-bed material and fill on many of the county's unpaved roads. Further investigation can better define these potential resources.

Table 1
(From Davis, 1946)

Sample/Location	Moisture Free Basis, Analysis in Per Cent									
	Proximate Analysis					Ultimate Analysis				
	Volatiles	Fixed	Ash	N	C	N	O	S	BTU Per Pound	Moisture Free
	Matter	Carbon								
Hampton										
sec. 30, T7S, R22E	48.5	33.7	17.8	4.0	53.4	2.0	22.5	0.3	8680	

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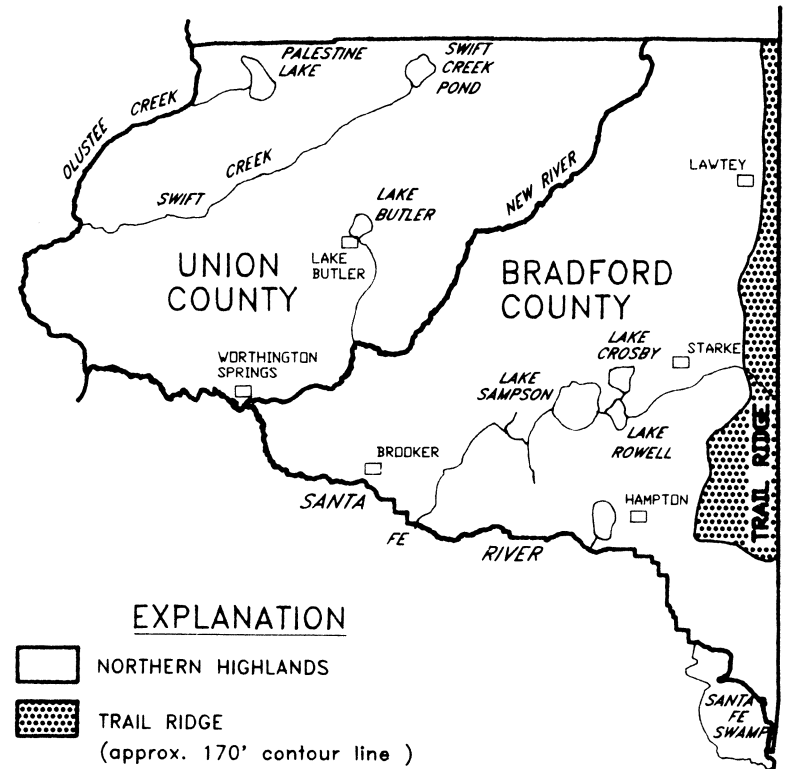


Figure 1. Geomorphology
(modified from White, 1970)

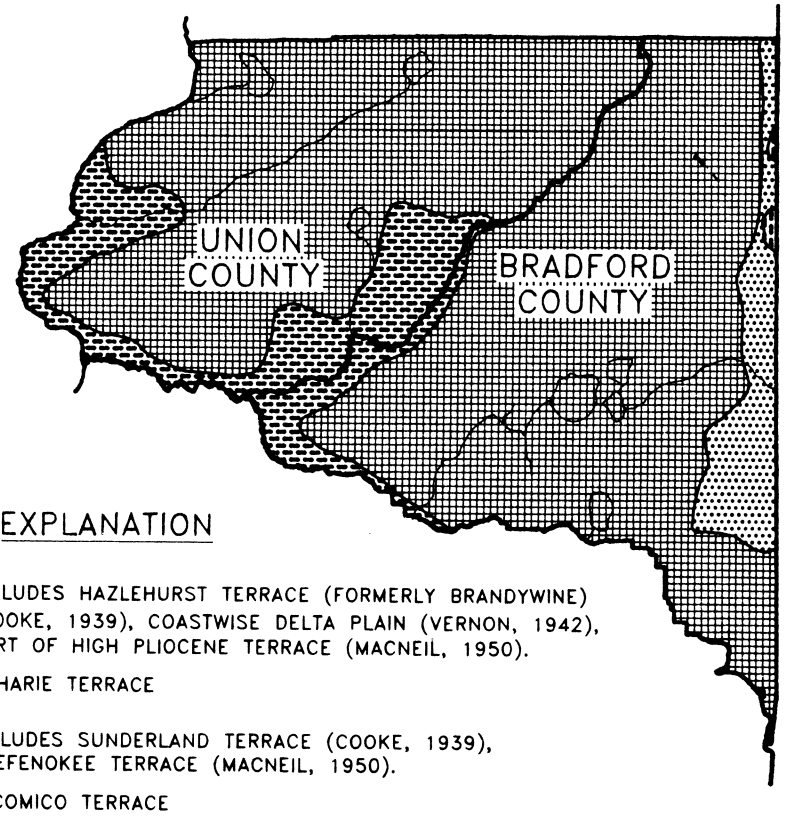


Figure 2. Terraces and Shorelines
(modified from Healy, 1975)

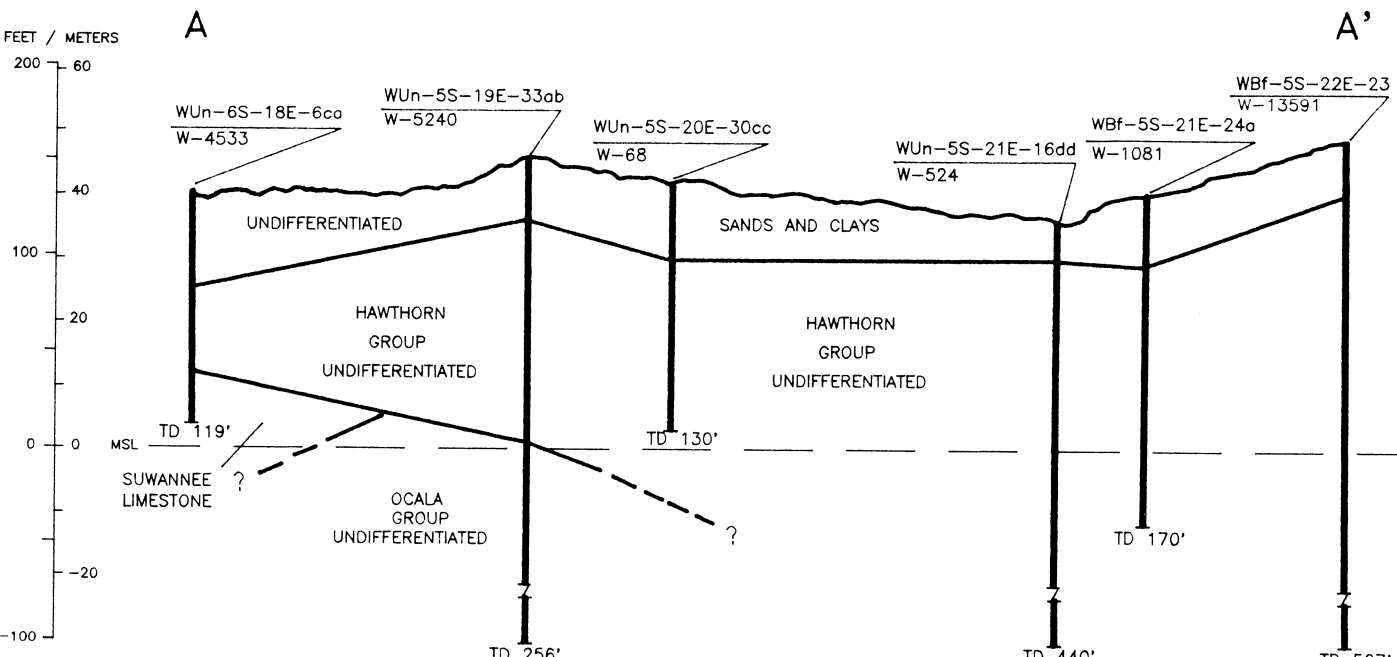


Figure 3b. Geologic Cross section A-A'

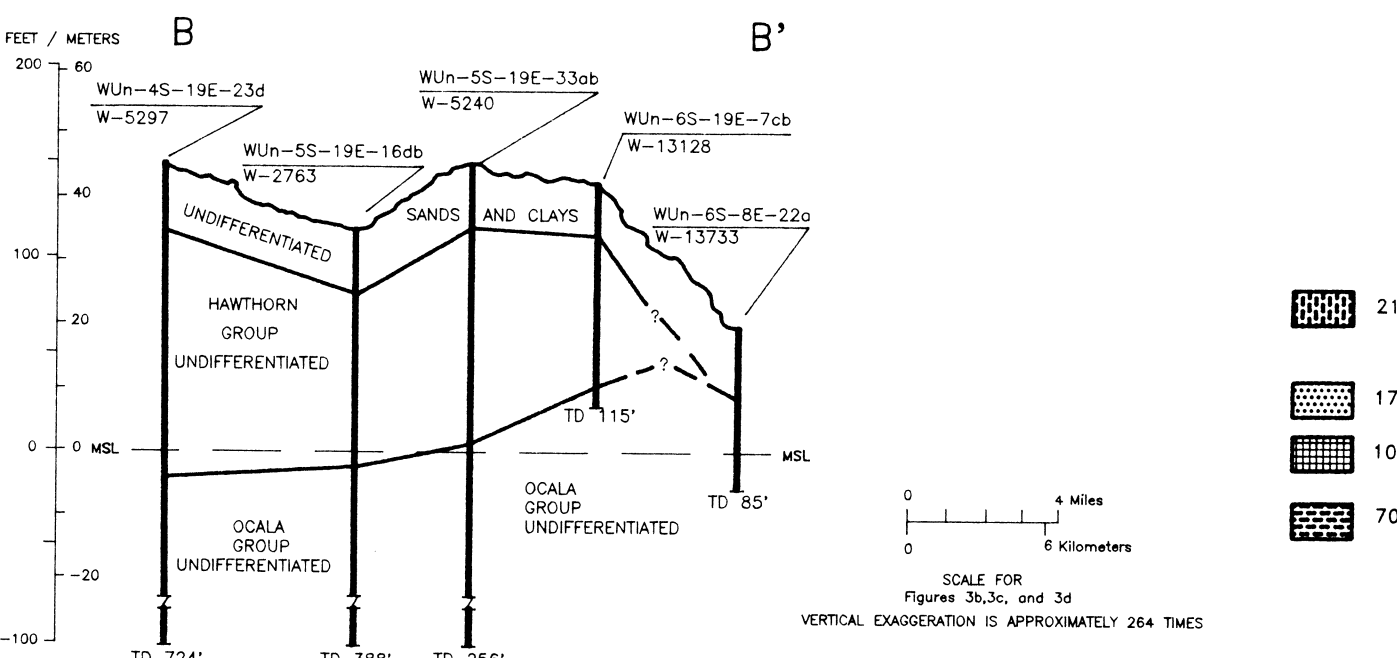


Figure 3c. Geologic Cross section B-B'

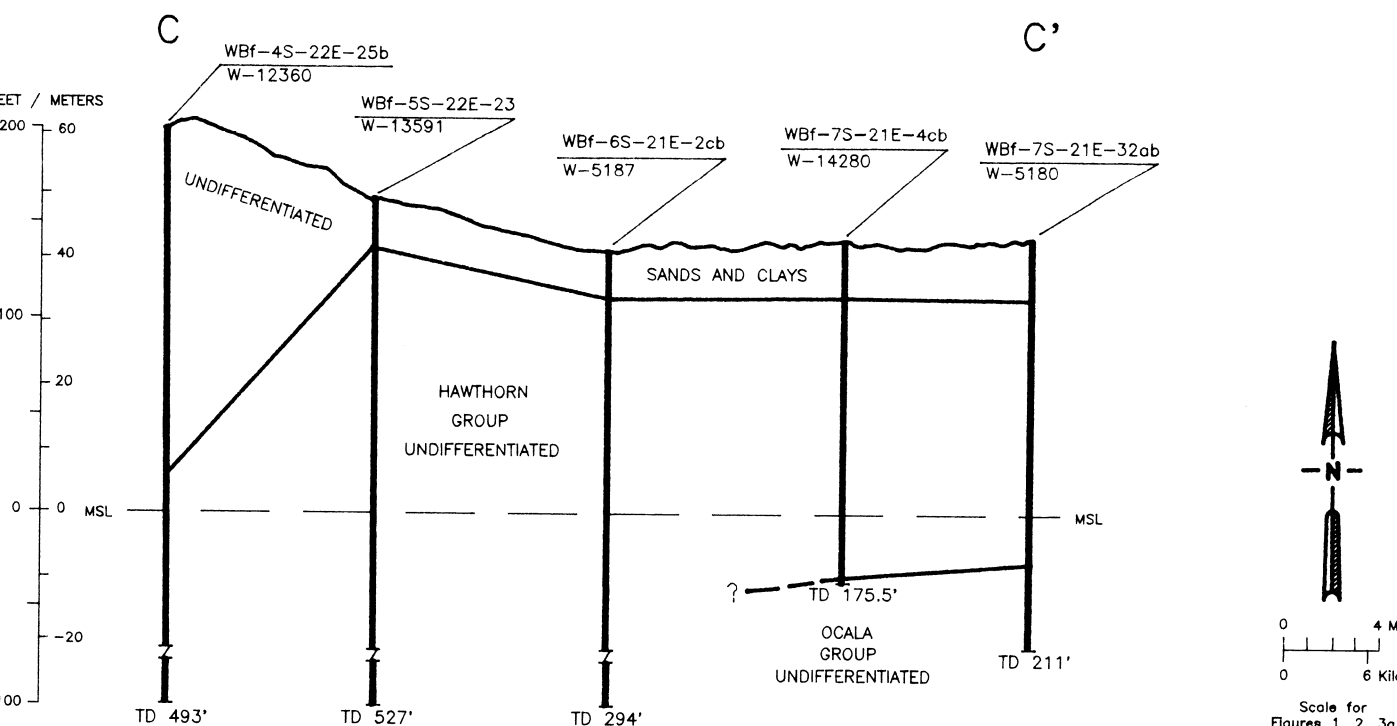


Figure 3d. Geologic Cross section C-C'

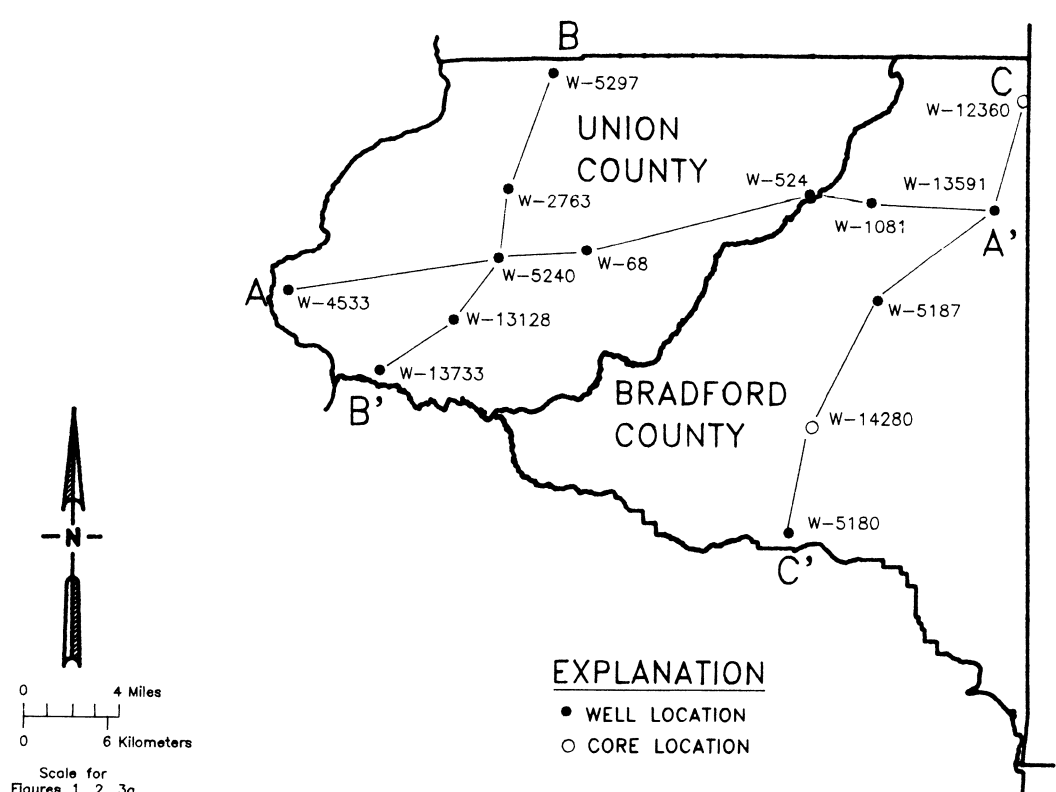


Figure 3a. Geologic Cross section locations