MAP SERIES NO. 136

FLORIDA GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES

Map Series No. 136

MINERAL RESOURCES OF COLUMBIA COUNTY, FLORIDA

By

Ed Lane, P.G. #141, Ronald W. Hoenstine,
and Steven M. Spencer

FLORIDA GEOLOGICAL SURVEY
WALTER SCHMIDT, STATE GEOLOGIST AND CHIEF
DIVISION OF RESOURCE MANAGEMENT
DEPARTMENT OF NATURAL RESOURCES

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COLUMBIA 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 underlain by known mineral deposits, precluding 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 population and urban growth, and Florida's mineral resource development 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 legislation, and at the request of the North Central Florida Regional Planning Council, the Florida Geological Survey initiated this investigation of Columbia County's mineral resources. The objectives were to identify potential mineral areas and to present the results in a format appropriate for use by city and county planners. This mineral resource assessment is general and is intended as a land-use planning tool. A site-specific evaluation would require detailed research beyond the scope of this investigation.

A knowledge of Columbia 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.

Resource evaluation for this report is based on a number of sources including Florida Geological Survey reports and unpublished data, core and well cutting descriptions, geological logs, field reconnaissance, state and federal statistical data, company reports, questionnaires, and 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

For readers who prefer metric units to the U. S. units used 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

White (1970) placed Columbia County within his Northern (Proximal) and Central (Mid-peninsular) Zones. The line separating these major geomorphic regions approximates a line passing through the cities of St. Augustine, Palatka, Hawthorne, Gainesville, Fort White, and Live Oak.

The Northern Zone encompasses the northern part of the state extending from Trail Ridge on the east to the Alabama-Florida panhandle boundary on the west. Included in this zone is the Northern Highlands, a major geomorphic feature encompassing the majority of Columbia County (Figure 1). Topographically, this area is characterized by broad rolling uplands. In this area are a number of surface water bodies ranging from large features such as Alligator Lake, to numerous small ponds, many of which are concentrated in west-central Columbia County. In addition, the Osceola National Forest covers much of the central part of the county.

The Northern Highlands are bounded to the south by the Cody Scarp, a relict marine feature named and described by Puri and Vernon (1964) as the most persistent topographic break in the state. White (1970) placed the toe of the Cody Scarp at approximately 100 feet above mean sea level (MSL). The trend of the Cody Scarp is irregular and difficult to follow in Columbia County. Commencing at the Alachua-Columbia County line in southeastern Columbia County, the Cody Scarp first trends westward then changes direction to the north, and finally turns to the southwest in a sinuous path into neighboring Suwannee County.

The Cody Scarp forms a boundary separating the Northern Highlands from the Central Highlands in Columbia County. White (1970) suggested that the Northern Highlands and Central Highlands may be remnants of a once continuous highland which has been dissected by erosion and dissolution leaving the present ridges of the Central Highlands and the more continuous uplands of the Northern Highlands.

The Central Highlands is present in the extreme southwestern portion of the county. In general, this geomorphic feature, which in Columbia County includes the northern portion of the Western Valley, is comprised of localized topographic highs which rise above uplands of considerably less elevation and relief. Also, White (1970) identified the High Springs Gap, a geomorphic feature having lower elevations than both the Northern Highlands to the north and the Brooksville Ridge to the south in neighboring Alachua County (Figure 1).

A number of marine terraces are present in the county (Figure 2). These plains, generally considered depositional features, were formed by higher sea stands during the Pleistocene; some are thought to be of Miocene age. Healy (1975) recognized three terraces in Columbia County based on elevation. From highest to lowest, these terraces include the Coharie Terrace (170 to 215 feet above MSL), the Sunderland/Okefenokee Terrace (100 to 170 feet above MSL), and the Wicomico Terrace (70 to 100 feet above MSL). The higher Coharie and Sunderland/Okefenokee Terraces are primarily located in the Northern Highlands. In contrast, the Central Highlands contain the lower elevations associated with the Wicomico Terrace.

GEOLOGY

Columbia County is underlain by basement rocks of Paleozoic age consisting of diabase, basalt sills and black shale. To date, the deepest penetration of sediments underlying Columbia County occurred in oil test well W-1789 (section 22, Township 1N, Range 17E). This Humble Oil and Refining Company well, which was drilled to a total depth of 4,303 feet below MSL, encountered Paleozoic black shales at a depth of 3,351 feet below MSL (Applin, 1951; Lloyd, 1985). Overlying these basement rocks are thousands of feet of Mesozoic and Cenozoic Erathem carbonates (limestones and dolomite). In the near-surface throughout Columbia County, these carbonates are overlain by a diversity of siliciclastic sediments and carbonates (i.e., quartz sand, clayey sand, sandy clay, silt, limestone, dolomite, and organic soils or peat).

These near-surface sediments include the Ocala Limestone, which locally forms part of the upper Floridan aquifer system. The Ocala Limestone, deposited during the Late Eocene Epoch (approximately 41 to 38 million years ago), is the oldest rock penetrated by water wells in the county. Referred to in the geologic cross sections (Figures 3b and 3c) as the Ocala Limestone, these sediments range from a white to tan to brown, recrystallized limestone to a chalky, cream colored, fossiliferous limestone.

Present throughout Columbia County, the top of this unit is encountered at depths ranging from approximately 60 feet above MSL in an area six miles south of Lake City (W-4216, section 33ca, Township 4S, Range 17E) to depths greater than 200 feet below MSL in the northeastern part of the county (Florida Geological Survey well data). The Ocala limestone is exposed in quarries located in the southwestern portion of the county.

The Oligocene Series Suwannee Limestone (38 to 33 million years BP) has limited occurrences in Columbia County, being confined primarily in the subsurface of the northwestern portion of the county, where it unconformably overlies the Ocala Limestone. The Suwannee Limestone, which comprises the upper part of the Floridan aquifer system in this area, occurs primarily as an indurated, cream to yellow, chalky limestone. In geologic cross sections used in this report, the top of this unit is present at elevations ranging from a high of approximately 35 feet above MSL in an area three miles west of Lake City to a minimum of 125 feet below MSL in north-central Columbia County (Figures 3b and 3c).

Sediments of the Hawthorn Group unconformably overlie the Ocala Limestone, except in the western third of the county, where they unconformably overlie the Suwannee Limestone. Deposited during the Early and Middle Miocene Epoch (approximately 23 to 15 million years ago), these sediments, which are referred to in the cross sections as "Hawthorn Group Undifferentiated" (Figures 3b and 3c), consist of phosphatic clays, sands, limestone and dolomite. The Hawthorn Group can be observed at a number of sites along the Suwannee River, including an excellent outcrop at White Springs.

Variable in thickness, the Hawthorn Group ranges from a maximum observed value of approximately 300 feet in the northeastern portion of the county to a minimum observed value of less than 50 feet in the vicinity of northeastern Lake City (FGS well data). Figure 3b shows the Hawthorn Group to have a thickness of 267 feet in W-15923 (section 14ac, Township 1N, Range 17E.)

A veneer of undifferentiated sands and clays cover the majority of Columbia County. Associated with past sea level stands and lacustrine deposits, and ranging in age from possibly Miocene, Pleistocene, and Holocene, these sediments are variable in lithology, consisting of fine to medium size sand, silt and clay. Thicknesses shown in the geologic cross sections range from a maximum value of 30 feet in W-4216 (section 33ca, Township 4S, Range 17E) to a minimum value of less than 2 feet in W-7108 (section 15bd, Township 4S, Range 18E.)

MINERAL RESOURCES
Introduction

The purpose of the following discussion is to provide information on the occurrence of certain economic mineral commodities in Columbia County. The Mineral Resources Map is designed to present a geographic overview of the major economic mineral commodities identified in Columbia 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 warrant further investigation. 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 discussed here include clay, limestone, peat, phosphate, and sand.

Clay

Sandy clays occur sporadically in the surface and near-surface sediments of Columbia County. The county road department has a number of minor borrow pits located throughout the county; sediments from which are used to maintain roads. Historically, in the Lake City region, clayey sediments were used to produce common brick (Bell, 1924). Bell (1924) performed tests on clays from this region, the results of which are shown in Tables 1 and 2. Clayey sediments are also present in the near-surface between Lake City and White Springs. Bell (1924) examined the sediments of this area and tested a clay deposit from an outcrop on the Hamilton County side of the Suwannee River near the U.S. Highway 100 bridge (section 8, Township 2S, Range 16E). Results of tests conducted on this clay showed it to be unsatisfactory for commercial use. More recently, the Florida Geological Survey sampled clayey sediments (section 28, Township 5S, Range 17E). Results of tests conducted by the U.S. Bureau of Mines on these samples show that these clays have no commercial potential at this time.

The U.S. Soil Conservation Service (SCS, 1981) shows loamy or clayey soils to be common throughout Columbia County. One of these soil types is the Oleno Clay, the mineralogy of which is primarily montmorillonite (smectite) with lesser amounts of kaolinite and quartz sand. This clay is present along portions of the Ichetucknee and Santa Fe Rivers (Mineral Resources Map). These SCS soil identifications are based on sediments sampled to a maximum depth of 80 inches below land surface.

Clay from Columbia County has low economic potential due to impurities and the lack of nearby market. These factors will probably prevent development of clay resources in the near future.

Table 1
Lake City Brickyard Clay
Three miles southwest of Lake City (from Bell, 1924)

Plasticity, judged by feel	Poor
Water of plasticity	17.45%
Pore water	0.23%
Shrinkage water	17.22%
Linear air shrinkage	3.60%
Volume air shrinkage	7.92%
Modulus of rupture, average	121.00 lbs. per sq. in.
Slaking test	30 hours

Fire Tests:

Temp. °C	Linear Shrinkage Per Cent	Absorption Per Cent	Porosity Per Cent	Color
950	0.6	15.18	33.60	Cream
1050	1.1	15.22	34.20	Cream
1150	1.6	14.50	33.60	Cream

Remarks: Test results show this clay to have low plasticity, bonding strength, and poor working qualities. It's soft and porous at cone 15. This clay was used for common brick.

Table 2
Cone Property Clay
Four miles north of Lake City on Benton Road
(from Bell, 1924)

Plasticity, judged by feel	Fair
Water of plasticity	41.20%
Linear air shrinkage	14.70%
Volume air shrinkage	46.20%
Modulus of rupture, average	1075.30 lbs. per sq. inch
Slaking test	15 minutes
Steel hard at cone 10	
Overfires at cone 1	

Fire Tests:

Temp. °C	Linear Shrinkage Per Cent	Absorption Per Cent	Porosity Per Cent	Color
950	6.3	5.54	25.75	Brick red
1050	7.8	4.80	24.25	Brick red
1150	8.3	3.58	22.25	Brick red

Remarks: Test results show the plasticity is fair, and its air shrinkage is high. It has a high modulus of rupture.

Limestone

Limestone is present in the near-surface in the southern one-third of Columbia County (Mineral Resources Map). In this region the limestone belongs to the Eocene age Ocala Limestone. The top of limestone has an approximate elevation of 30 feet above MSL while land surface elevations in the mining area vary from 40 to 50 feet above MSL. Limestone sporadically crops out in and along the Ichetucknee and Santa Fe Rivers.

Two companies are mining limestone three miles southwest of Columbia City: Anderson Mining Company (sections 20 and 21, Township 5S, Range 16E) and Limerock Industries Incorporated (sections 16, 17, 20, and 21, Township 5S, Range 16E). A significant portion of the limestone mined by these companies is used in Florida Department of Transportation (DOT) funded projects. Anderson Mining Corporation produces a limerock base used in road building for the DOT. Limerock Industries Incorporated produces, in addition to limerock base, screenings suitable as an additive in asphalt for the DOT.

As with all other commodities mined in Florida, limestone from Columbia County is extracted by open pit mining methods. Draglines remove the rock from the ground and place it in stockpiles which allow it to dry. The rock is crushed, screened, and prepared for market.

Limestone production is greatly affected by transportation cost. For economic reasons companies transport their products to nearby areas such as Lake City and Fort White in Columbia County, Live Oak in Suwannee County, and to many towns in the Union-Bradford County area. Transportation of the product occurs primarily by truck.

There is a long history of limestone mining in the Columbia County region. Reserves, although held in strict confidentiality by the companies, are estimated by the authors to be large enough to last well into the future.

Peat

Peat is a product of partially decomposed organic materials which accumulate when the depositional rate exceeds decomposition (Davis, 1946; Bond et al., 1986). In perennially wet areas organisms which normally metabolize plant matter are inhibited, thereby allowing peat to form.

Davis (1946) traveled over much of Florida studying its peat resources. In Columbia County Davis (1946) tested one shallow (36 inch) peat deposit from an area along the eastern side of the Ichetucknee River (section 13, Township 6S, Range 15E). Results of that investigation are shown in Table 3.

Table 3. Peat Analysis
(from Davis, 1946)

Location (T,R,S)	Depth of deposit in inches	BTUs per pound moisture free
T06S, R15E, sec. 13	0-36	6480

Moisture Free Basis, Analysis in Percent

Proximate Analysis

Volatile Matter	Fixed Carbon	Ash
51.1	16.1	32.8

Ultimate Analysis

H	C	N	O	S
3.7	39.3	2.1	18.8	3.3

Cathcart, et al. (1987) studied peat accumulations in the Impassable Bay Roadless Area of northern Columbia County. They sampled 20 sites and, although peat was present, it was scattered and found not to be of substantial thickness. Much of the peat had an ash content greater than 25 percent, a value too high to be economical according to the American Society of Testing Materials (1969).

The U.S. Soil Conservation Service (SCS, 1981), which samples to a maximum depth of 80 inches, mapped a soil type, Dorovan Muck, as being present in northeastern Columbia County. This soil type is highly organic and in some areas of Florida is mined as peat.

Due to limited extent and thinness of the peat deposits, commercial mining operations are improbable at this time. However, further exploration of northern Columbia County for peat resources may be warranted due to the presence of suitable conditions for accumulation.

Phosphate

Columbia County is located in the Georgia-Florida phosphate district (Sever, et al., 1967). Although phosphate is not mined in Columbia County, it is mined in adjoining Hamilton County. Production in Hamilton County is from irregular phosphate deposits contained in the Miocene Epoch Hawthorn Group.

During the 1970s, phosphate exploration by numerous mining companies led to leases on 52,253 acres in the Osceola National Forest (U. S. Bureau of Land Management (BLM), 1974). In all, several thousand test wells were drilled to determine the presence of phosphate. The drilling logs remain proprietary and, therefore, are not available to the public. However, that prospecting led to the discovery of several hundred-million tons of matrix, a significant percentage of which is located on private lands in Hamilton and Columbia Counties (BLM, 1974). According to the BLM (1974) there are 100 million tons of proven reserves in the western one-half of the Osceola National Forest (Mineral Resource Map). The phosphate matrix from this region averages 8-10 feet thick, has an overburden of 25-30 feet, and an average grade of 68 percent Bone Phosphate of Lime (31.2% P_2O_5) (BLM, 1974).

Cathcart, et al. (1987) studied the mineral resources of the Impassable Bay Roadless Area in Columbia County. Based on drilling results, they determined the phosphatic sediments to be subeconomic, thereby precluding mining. However, this study concluded that these deposits will increase in economic value as current mined deposits are depleted.

Additionally, data from FGS wells W-1037 and W-1038 (Mineral Resources Map) suggests that portions of extreme north-central and northwestern Columbia County may contain phosphate deposits of economic value. Although well coverage in the area is sparse, the presence of phosphate-rich sediments within 40 feet of land surface containing up to 45 percent phosphorite (visual estimates of sediments from these two wells) deserves further investigation (Mineral Resources Map).

Sand

Clayey sand forms the surface sediments of Columbia County. In the Impassable Bay Roadless Area, sand has little if any commercial value since it is too fine grained for most construction uses, and because other regions in northern Florida have better quality sand resources (Cathcart, et al., 1987).

The U. S. Forest Service extracts clayey sand from borrow pits in the Osceola National Forest where the sediments are used for road repair and stabilization. Additionally, the Columbia County Road Department uses clayey sand from a number of borrow pits to maintain its roads.

Undifferentiated Resources

Much of Columbia County has surface and near-surface sediments comprised of clayey sand, sandy clay, sand, marl, and organic muck. These undifferentiated resources have extensive occurrences in the northern one-half of the county. The potential for large scale mining is minimal due to the heterogeneous nature of these sediments. However, the sediments are valuable as a local source for fill since many areas are subject to flooding and require fill for building and development purposes.

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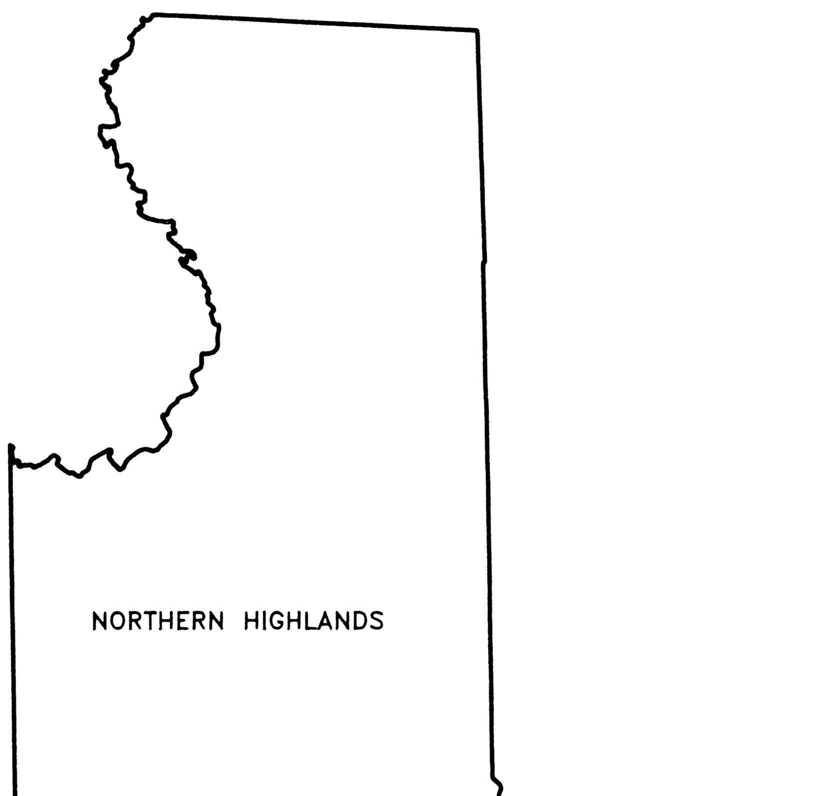


FIGURE 1. GEOMORPHOLOGY
(modified from White, 1970)

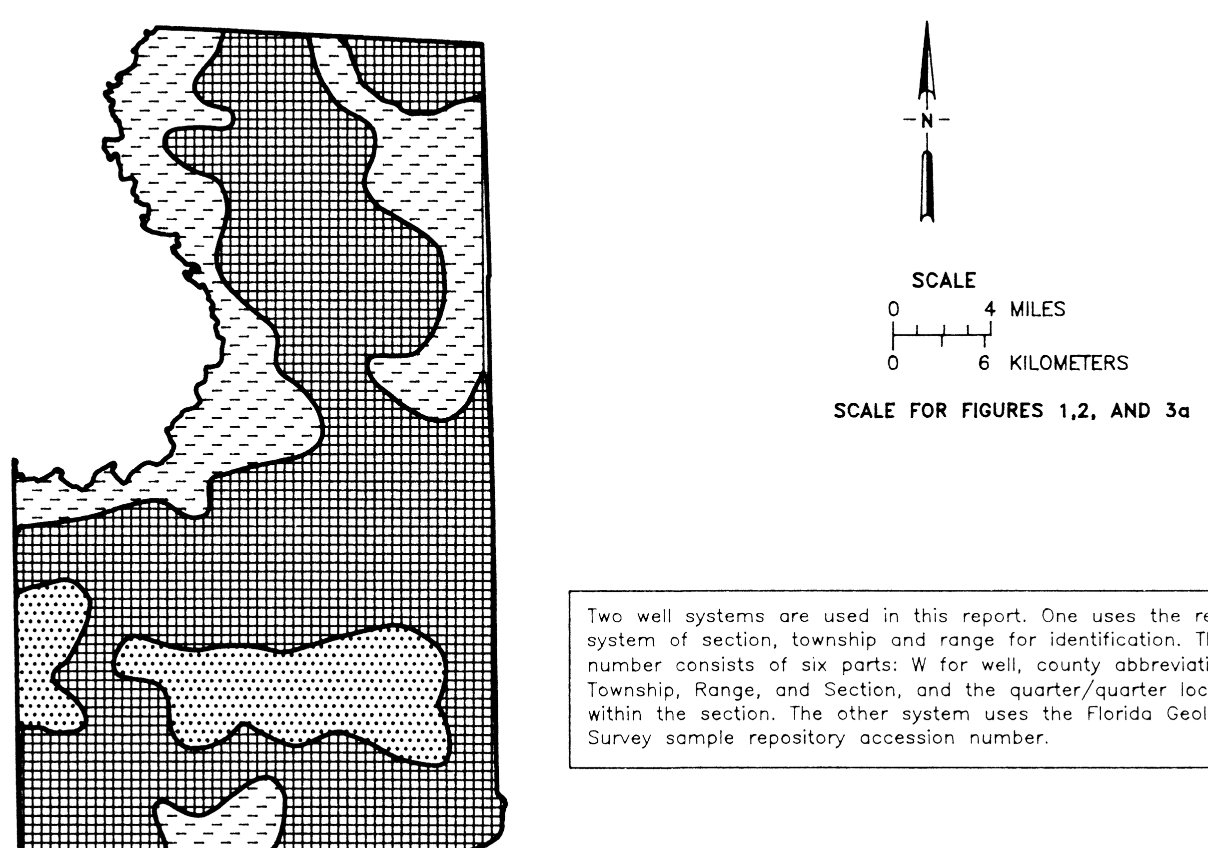


FIGURE 2. TERRACES AND SHORELINES
(modified from Healy, 1975)

SCALE FOR FIGURES 1,2, AND 3a

Two well systems are used in this report. One uses the rectangular system of section, township and range for identification. The well number consists of six parts: W for well, county abbreviations, the Township, Range, and Section, and the quarter/quarter location within the section. The other system uses the Florida Geological Survey sample repository accession number.

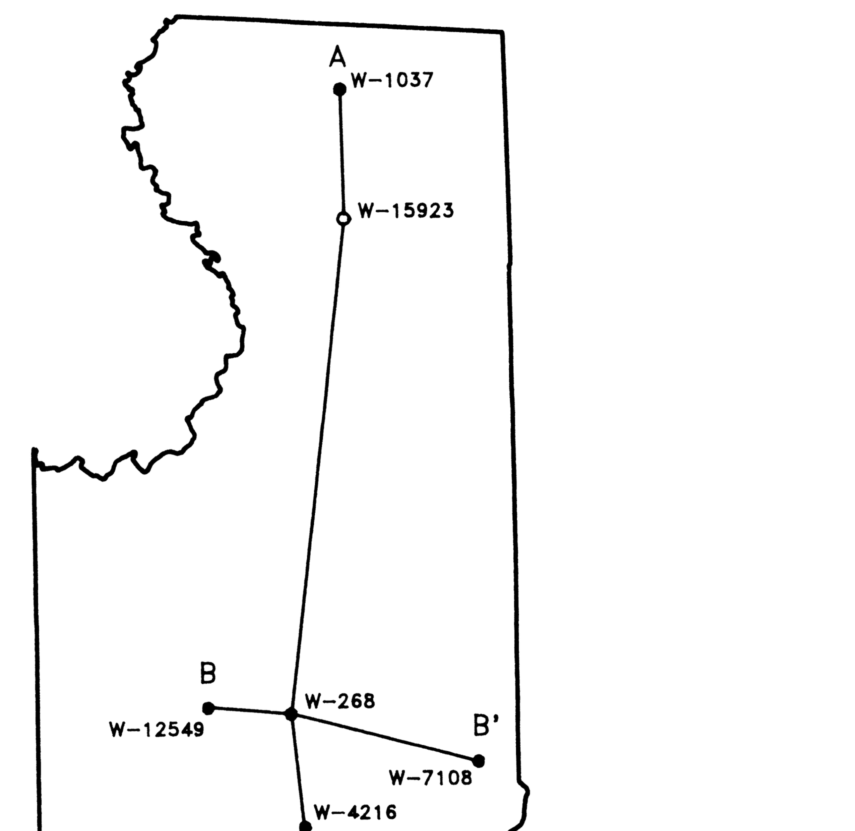
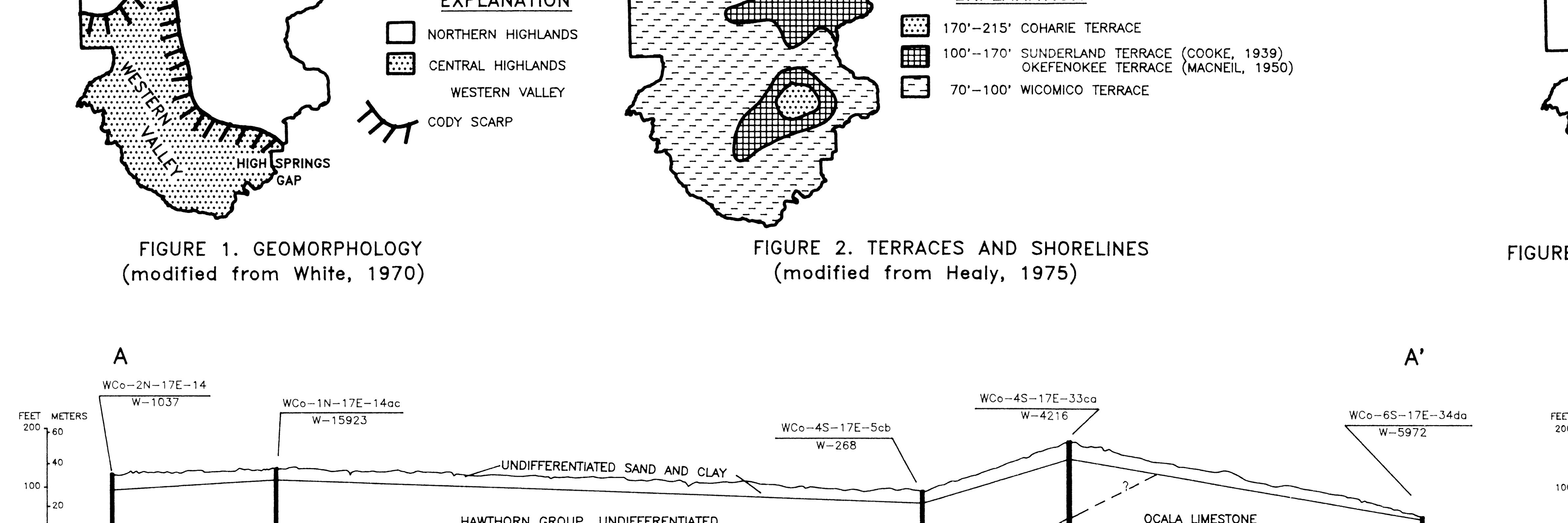


FIGURE 3a. GEOLOGIC CROSS SECTION LOCATIONS



VERTICAL EXAGGERATION FOR FIGURES 3B AND 3C IS APPROXIMATELY 105 TIMES HORIZONTAL

FIGURE 3b. GEOLOGIC CROSS SECTION A–A'

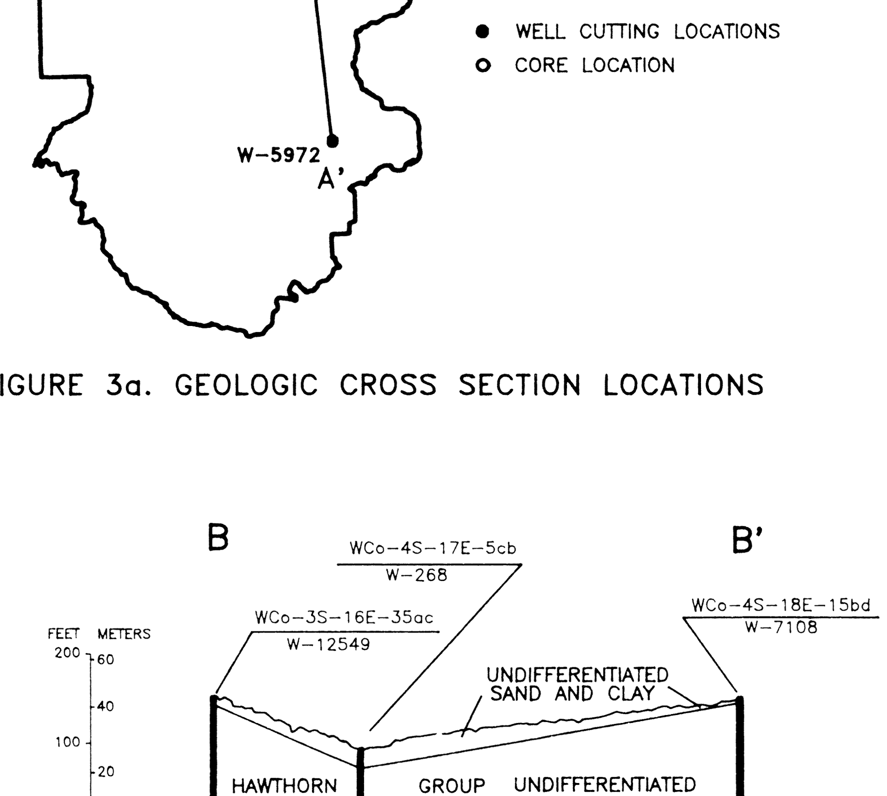


FIGURE 3c. GEOLOGIC CROSS SECTION B–B'