SPECIAL PUBLICATION NO. 8
(REVISED)

GUIDE TO ROCKS AND MINERALS
OF FLORIDA

by
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Tallahassee
1987
Governor Bob Martinez, Chairman
Florida Department of Natural Resources
Tallahassee, Florida 32301

Dear Governor Martinez:

The Bureau of Geology, Division of Resource Management, Department of Natural Resources, is republishing its Special Publication No. 8, "Guide to Rocks and Minerals of Florida". This revised edition presents geological information regarding part of Florida's natural resources. This publication will be useful as an educational resource for scientists, teachers, public officials, tourists, and the general public.

Sincerely,

Walter Schmidt, Chief
Bureau of Geology
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FOREWORD

This completely revised and illustrated edition is the result of continuing efforts of the staff of the Florida Geological Survey in exploring, studying, and collecting the rocks and minerals of the State. Since the first edition in 1961, the Survey staff has discovered and acquired many new, splendid, and sometimes rare, specimens of native rocks and minerals. Most of the specimens shown and many more can be seen at the Survey offices, located on the campus of Florida State University, Tallahassee.
COLLECTING ROCKS AND MINERALS

This book has been written to provide basic geological knowledge of rocks and minerals that occur in Florida. This knowledge will serve as a guide in the search for rocks and minerals, and as a basis for a better appreciation of Florida's natural environment.

Collecting rocks and minerals can be a rewarding hobby from an educational standpoint and from the satisfaction of having a personal collection of nature's beautiful creations. Many rocks and mineral specimens can be jewel-like, in every esthetic sense, especially after cleaning, cutting, or polishing, and mounting for display.

As with any hobby, much of the pleasure of collecting is in the hunting-and-finding, and the discovery of particularly fine specimens. However, the observance of a few common-sense rules can add to the pleasure of the search. The pursuit of collecting can lead one to quarries, road cuts, ditch banks, spoil piles, and similar locations—all potentially dangerous. The collector must always remember the two “P’s”: Permission and Personal safety. Remember, anywhere you go, the property belongs to someone else, and you must obtain prior permission before trespassing. Quarries and construction sites are especially hazardous due to falling rocks, blasting, and heavy equipment, and it is illegal to enter without written permission or without an escort. For the more serious collector, or for someone wishing to pursue more technical aspects of geology and mineralogy, a list of references has been provided.

EQUIPMENT

The collecting and identification of rocks and minerals requires only readily obtainable and inexpensive equipment. These basic supplies, in conjunction with easily applied tests, will enable one to identify the common rocks and minerals of Florida. A “rockhound's” kit should include the following items. Don't try to carry too much—but don't forget water and lunch.

SHOES: A pair of sturdy, ankle-high shoes or “boondockers” will provide support for hiking to outcrops, as well as protection from sharp rocks.

FIELD BAG: A knapsack, preferably with a shoulder strap, or a backpack, to carry equipment and specimens.

WRAPPING MATERIAL: Newspapers are good. A few turns of newspaper around each specimen will protect it against damage from other specimens and equipment in your field bag.
NOTEBOOK AND PENCIL: For recording field notes and labelling specimens.
HAMMER: A geologist's or bricklayers hammer is a necessity. Be careful of flying splinters when hammering on rocks; safety glasses or goggles are recommended.
CHISEL: Some rocks and minerals occur as hard, massive bodies, and a chisel can help to obtain more easily manageable specimens. Also, it is less destructive than a hammer when dealing with fragile specimens, such as crystals.
MAGNIFYING GLASS: Small, folding types, 5x to 10x, are best. A length of string around the neck or belt loop will keep it handy.
GLOVES: Cotton or leather work gloves afford protection when dealing with sharp-edged specimens.
ACID: Hydrochloric acid (10% concentration) is a standard reagent to test for carbonate rocks and minerals, which are abundant in Florida. It should be kept in a plastic container, preferably with an eyedropper top. The test procedure is to place a small drop of acid on a clean surface of the specimen and observe whether or not it effervesces. Be careful, the acid will burn your skin.
STREAK PLATE: A small piece of white, unglazed porcelain (about 2" x 2"); the back of glazed tile can be used. The specimen is rubbed against the plate and the color of the streak is noted.
OTHER ITEMS: You may want to include a pocket knife, camera, compass, small plastic vials for protecting delicate specimens such as crystals or fossils, and other identification guides to rocks and minerals.

ROCKS

Rocks are aggregates of minerals that comprise the earth's crust. The earth's crust is not homogeneous. Its surface and interior are made of an almost infinite variety of rocks, each having its own distinctive characteristics, such as color, density, porosity, and hardness. The great range in appearance and physical properties that they exhibit depends on the kinds and amounts of minerals they contain, and upon the ways in which their mineral grains are held together. Geologists use a genetic classification of rocks, according to their origin: igneous, metamorphic, or sedimentary.

IGNEOUS ROCKS

Igneous rocks (from the Latin word ignis, meaning fire) are formed deep within the earth's molten interior. Sometimes they are brought to the surface during volcanic eruptions; these are called extrusives. Examples of extrusive rocks are basalts, obsidian (volcanic glass), and pumice (the porous, bubble-filled lava that floats on water). Igneous rocks that are migrating upward from the earth's interior sometimes do not reach the surface to be extruded. These rocks are classified as intrusives or plutonic rocks. They may be squeezed between layers of
rocks, forming tabular sills; they may cut across or through layers of rocks at angles, forming dikes; or they may form large bodies of rocks at depth when the magma becomes consolidated. The best-known examples of intrusive igneous rocks are granites. There are no igneous rocks exposed at the surface in Florida, although some have been found at depths of several thousand or more feet in wells throughout the state (Lloyd, 1985).

METAMORPHIC ROCKS

Metamorphic rocks (from the Greek words *meta morphos* for “changed form”) form deep beneath the surface of the earth by the transformation of rocks, such as igneous or sedimentary rocks, as well as other metamorphic rocks, by the heat, pressure, and chemically active fluids to which they are subjected after burial in the earth. Examples of metamorphic rocks are slate (metamorphosed shale), marble (metamorphosed limestone), and quartzite (metamorphosed quartz sandstone). There are no metamorphic rocks exposed at the surface in Florida, although some have been encountered at depths of several thousand feet or more in wells (Lloyd, 1985).

SEDIMENTARY ROCKS

All rocks exposed in Florida are of sedimentary origin. Sedimentary rocks are those that were formed at the earth’s surface under normal temperatures and pressures. They form either by accumulation and cementation of fragments of rocks, minerals, the remains of plants or animals, or as precipitates from sea water, surface water, or groundwater. Sedimentary rocks often have a layered structure known as bedding or stratification. Sedimentary rocks are classified into three groups: clastics, chemical precipitates, and organic accumulations (Hamblin and Howard, 1965).

CLASTIC sedimentary rocks are the result of the weathering, breaking down, and erosion of older parent rocks. Physical and chemical weathering breaks down parent rocks into smaller fragments, which are transported some distance from their source and deposited. These deposits may then become compacted and cemented into solid rock. Sandstone, for example, is the cemented counterpart of loose sand deposits. Other representative clastic deposits are, in a descending range of particle size: gravels, sands, silts, and clays.

Clastic deposits of sands and clays blanket most of Florida. The ultimate source of Florida’s clastics is from the Appalachian Mountains to the north in Alabama and Georgia. Millions of years of weathering and erosion wore down the mountains. Streams carried the debris south to Florida, where subsequently stream and shoreline processes created the present landforms.

Sandstone

*Sandstone* is a sedimentary rock composed of grains of quartz sand
cemented together. In Florida the most common cements are calcite or silica, and sometimes iron oxides. Since most Florida quartz sand is white or colorless, a sandstone's color is due to the type and amount of cement. Colors of Florida sandstones range from white through various tints of yellow, orange, red, or brown. Sandstones occur throughout the State and may be associated with sands, clays, or carbonates. It may be found as small nodules, as thin discontinuous strata, or in beds several feet thick.

Clays

The term clay can have three implications: (1) it may refer to a natural material that has plastic properties when wet, (2) it may refer to particles of very fine size, or (3) it can mean a composition of crystalline fragments of minerals that are usually hydrous aluminum or magnesium silicates. The term implies nothing regarding origin but is based on properties, texture, or composition.

Clays form as the result of chemical or mechanical weathering and erosion of parent rocks and minerals. Clay-sized particles are less than 0.004 mm in length. Much of the clay in Florida was deposited as mud in streams, river deltas, lakes or sea beds. The predominant Florida clay minerals include kaolinite, montmorillonite, illite, and palygorskite (also called attapulgite). These usually have wide ranges in chemical composition because of the possible inclusion of many impurities, such as iron oxides, carbonates, mica, potassium, sodium, feldspar, and others.

Clays mined in Florida at present are classified as: common clays, fuller's earth, and kaolin. Except for kaolin, these clays are generally composed of varying amounts of the minerals montmorillonite, illite, palygorskite, or kaolinite.

Common Clays

Common clays are composed of varying amounts of clay minerals, quartz sand, calcite, iron oxides, organic materials, and other impurities. They can exhibit wide ranges of plasticity and color, depending on mineralogy, amounts of impurities, and degree of weathering (Figure 1).

Common clays occur in most counties north of Lake Okeechobee (Bishop and Dee, 1961). Escambia and Santa Rosa counties, and the St. Johns River valley from Jacksonville to Lake George have large deposits of common clay. Smaller deposits of common clay occur in many of the northern and panhandle counties.

These types of clays are used to manufacture bricks and light-weight aggregate (construction materials), and as additives to Portland cement and to sand for roads.
Figure 1. Common clay from the Miccosukee Formation, northeastern panhandle of Florida. The dark reddish-pink streaks and mottles in a lighter pink matrix of these specimens are typical of the Miccosukee Formation. Outcrops often show mottles of white kaolin clay. Florida Geological Survey collection.
Fuller’s Earth

Fuller’s earth is an old colloquial name that refers to the ability of certain clays to “full” or absorb oils from wools or textiles; the name has no implication to mineralogy or composition. Florida’s fuller’s earth clays are composed of the minerals palygorskite (attapulgite) and/or varieties of montmorillonite, and sometimes illite. They are blue to gray to light gray-green in color, and waxy and plastic (Figure 2).

Sizeable near-surface deposits occur in Gadsden, Marion, Pinellas, and Manatee counties; small deposits occur in several other counties. Active mining is done only in Gadsden and Marion counties, but fuller’s earth has been mined in the past in Manatee County (Bishop and Dee, 1961). Florida ranked second nationally in 1984 in output of fuller’s earth (U.S. Bureau of Mines, 1984).

High grade fuller’s earth is composed of almost pure palygorskite and is useful for its ability to gel, or coagulate. These gelling characteristics are important in drilling mud, liquid fertilizer suspenders, paint thickeners, and some medical drugs. Lower grades of fuller’s earth, which are mixtures of palygorskite, illite, and montmorillonite, are used in various products, such as petroleum, vegetable and mineral oil absorbents, pet litter, insecticides and fungicide carriers, and as additives in soaps, paints, polishes, and some plastics.

Montmorillonite

Montmorillonite deserves special mention because of its outstanding characteristic of “swelling or bloating” when wetted. This ability to absorb large quantities of water and to expand considerably in volume can cause severe problems and damage to man-made structures that are built over deposits of it. This is one of the main reasons that building codes require soil test borings for building foundations. As an additive to certain types of drilling muds, this property is put to beneficial use, where the object is to plug the voids in porous rocks.

Kaolin

Kaolin is composed of the clay mineral kaolinite. Florida kaolin is generally light-colored, soft, lightweight, and often chalk-like. It is porous and will stick to the tongue, and will crumble rapidly when placed in water.

There is only one active kaolin mine in Florida, in western Putnam County, but large deposits also occur from southern Clay to northern Highlands counties (Campbell, 1986). In the panhandle, a narrow belt of deposits extends from Jackson County into Santa Rosa County.

High grade clay, called china clay, is used to manufacture china and porcelain, and ceramics. Other uses include fillers in paints, paper, soaps, tooth powders, crayons, textiles, and other products.

CHEMICAL PRECIPITATES are formed from sea water, groundwater, or other solutions on the earth’s surface. Representative Florida
Figure 2. Fuller’s earth, Gadsden County, from the Hawthorn Group, lower Miocene. This specimen has dried out and split apart along laminated bedding planes. Florida Geological Survey Collection.
rocks are anhydrite and gypsum (discussed in the Mineral Identification section), limestones (see below), and some types of dolomites (see Mineral Identification section).

Limestone

A discussion of limestone is important because it occurs throughout Florida, and because it figures so prominently in the natural and geological histories of the State. Limestone production is a major industry in Florida, with most of it being used to make cement and as crushed rock for road surfacing. Other uses include rip-rap, soil conditioner, lime production, building stone, and in the chemical industry.

Mineralogically, limestones are sedimentary rocks that contain more than 50 percent of the mineral calcite (calcium carbonate, CaCO₃). Impurities may range up to 50 percent. Common impurities found in Florida limestones are chert, quartz sand, clay, and iron oxides.

Most limestone in Florida is biogenic in origin. A great many species of marine and fresh water animals and plants secrete calcium carbonate as part of their life processes, forming shells and other internal and external support structures. When an organism dies its calcitic remains are incorporated into the sediments of the body of water. Over time these biogenic remains may become cemented together, forming limestone; coquina is an example. In Florida, as in many places in the world, biogenic limestones constitute the major portions of layers of rock that are hundreds or thousands-of-feet thick.

Chemical processes also contribute smaller quantities of calcite to Florida sediments. Some is precipitated as crystals and some as cryptocrystalline or massive varieties, such as travertine (cave deposits). Three main varieties of limestone occur in Florida: fossiliferous limestone, coquina, and oolitic limestone.

Fossiliferous limestone (Figure 3) may contain abundant fossils of mollusks, echinoids, corals, Foraminifera, and other organisms. These fossils are usually cemented with calcite, forming a rock. In general, most Florida limestones are fossiliferous, although there may be local zones that are unfossiliferous. Some fossiliferous limestones represent ancient reef environments, such as the Key Largo Limestone, which forms the upper Florida Keys.

Coquina (Figure 4) is a type of limestone composed of cemented marine shell fragments. It sometimes contains much quartz sand. The Anastasia Formation is predominantly coquina, extending along the Atlantic coast from south of Jacksonville to Palm Beach County.

Oolitic limestone (Figure 5) is made of small, spherical calcite or aragonite grains with concentric or radial structured "ooliths." The ooliths range up to 2.0 mm in diameter and consist of calcitic layers precipitated around foreign particles, such as sand grains, shell fragments, fossils, or other matter. Calcite is the cementing agent. The Miami Limestone, in southernmost Florida and the lower Florida Keys, provides good exposures.
Figure 3. Three of the many species of fossil corals that make up much of the Key Largo Limestone, which comprises the upper Florida Keys. Although they are usually fragmented, it is possible to find intact specimens in outcrops or on spoil piles. Lower left: rose coral (*Manicina* sp.); upper left: common brain coral (*Diploria* sp.); right: porous coral (*Porites* sp.). Author’s collection.
Figure 4. This coquina occurs along the Atlantic coast as the Anastasia Formation. Fresh exposures may be weakly cemented and friable, but it generally becomes “casehardened” and durable after exposure to the elements. The old Spanish fort, Castillo de San Marcos in St. Augustine, is made of locally quarried coquina. Florida Geological Survey Collection.
Figure 5. Oolitic limestone from the Miami Limestone geological formation, Big Pine Key, Monroe County. This white to light cream colored limestone is composed almost entirely of tiny, spherical ooliths, each less than 1.0 mm in diameter. Florida Geological Survey Collection.
Dolomite

Dolomite refers both to a type of sedimentary carbonate rock and to a mineral (see mineral description). Most dolomite rock in Florida occurs as massive, dense units associated with limestones. Color varies from light to dark grays and browns. Because dolomite's chemical structure (CaMg(CO₃)₂) is similar to calcium carbonate's (CaCO₃), it can be used for many of the same purposes as limestone. It cannot be used to make cement because the magnesium (Mg) interferes with the cement's setting properties. Most of the dolomite produced in Florida is used as agricultural lime and some is used for road surfacing. Small amounts have been used as decorative building stone.

Phosphate

Phosphate, also called phosphorite, refers to deposits of phosphorus-bearing minerals. The principal mineral is francolite, calcium fluorapatite (Ca₅F(PO₄)₃), although other elements can substitute for calcium and fluorine to create a variety of phosphate minerals. Collophane is the massive, cryptocrystalline variety that constitutes the bulk of phosphate deposits and fossil bones; it usually contains some calcium carbonates as impurities (Figure 6).

Scattered deposits are found southward from the Georgia-Florida border in Hamilton and Columbia counties to Manatee and DeSoto counties. The types of deposits are known as "hard rock," "land pebble," and "river pebble." Hard rock deposits occur in the west-central peninsula, consisting of a conglomeration of pebbles and boulders with sands and clays. Hardrock phosphate occurs primarily as a replacement mineral replacing limestone.

The main land pebble deposits occur east of Tampa in Hillsborough, Hardee, Manatee, and Polk counties, consisting of hard, phosphatic pebbles and sands in a matrix of quartz sands and clays; fossil teeth and bones of marine and land animals are commonly found. Most of Florida's phosphate rock is produced from these deposits.

River pebble deposits occur along or near stream channels. The Peace River in Polk, Hardee, and DeSoto counties is a good example, although mining ceased there several decades ago.

The raw rock is converted into a variety of finished products, mostly fertilizers, with lesser amounts of phosphoric acid and animal feed supplements.

Florida has enormous phosphorite deposits, with enough reserves to continue the current rate of mining for more than 250 years. In 1983, Florida and North Carolina accounted for 87 percent of the total U.S. and 27 percent of the total world phosphate production (Campbell, 1986).

Organic accumulations that occur in Florida are peat and lignite, which are dark brown deposits produced by the partial decomposition of mosses, grasses, trees, and other plants that grow in wet, marshy places (Figure 7). The composition of Florida peats vary from a fibrous,
Figure 6. Hard rock phosphate, from a mine in northeastern Citrus County. This cut and polished specimen shows multi-hued brown banding. Thomas M. Scott collection.
Figure 7. Fibrous, matted peat from the Everglades. Florida Geological Survey Collection.
matted, turf-like material to a mud-like plastic ooze or slime. The most extensive deposits occur in the Everglades, extending from Lake Okeechobee south to Florida Bay. Other deposits occur south of Lake Istokpoga, and in the upper St. Johns River Valley, in Brevard and Indian River counties. Many smaller peat deposits occur throughout the State (Davis, 1946; Bond et al., 1986).

OTHER ROCKS, MINERALS, AND RELATED MATERIALS

This section includes those types of rocks and mineral-related specimens that occur in Florida, but which do not fit into the preceding categories. Included are economic "minerals," fossils, and rock-forms of minerals.

DIATOMACEOUS EARTH

Diatomaceous earth refers to deposits made almost entirely of the siliceous (quartz) skeletons (frustule) of microscopic, one-celled plants called diatoms. The great diversity and beauty of diatoms' open, silicic skeletons can only be seen with a powerful microscope (Figure 8). Usually associated with peat, diatomaceous earths are sometimes difficult to distinguish from the peat and organic mucks, although diatom deposits may form thin, white or light-colored bands within the darker peats (Davis, 1946). Thicker, consolidated beds resemble chalk or clay. The diatoms' open, lattice-work skeletons make ideal filters for some industrial and chemical processes. Diatomaceous earth has not been commercially produced in Florida since 1945 (Davis, 1946).

FOSSILS

Fossils are the remains of plants or animals of the past that have been preserved in the earth's crust. Under the right conditions any organism can be converted into a fossil. Many fossils have been preserved through petrifaction, a mineralization process whereby organic substances are turned to stone by circulating mineralized groundwater. Petrified wood is a perfect example of this kind of fossil, where the wood (cellulose) has been replaced by silica (quartz, opal) (Figure 9).

The bones and teeth of most vertebrates are the mineral calcium phosphate, and are often preserved relatively unchanged. Fossils of larger land vertebrates that may be found in Florida are the teeth and bones of saber-toothed tigers, mammoths, mastodons, rhinoceroses, horses, camels, sloths, and bears. Marine vertebrate fossils include sirenians (manatee-like animals), and whales. Shark teeth are plentiful in some strata (Figure 10). A more detailed description of some Florida vertebrate fossils can be found in Fossil Mammals of Florida (Olsen, 1959).

The most numerous fossils found in Florida are of invertebrate marine animals, which illustrate a common method of preservation (Figure 11).
Figure 8. Photographs of diatom frustules taken with a microscope, showing the open frameworks that make them useful as filters. A = Coscinodiscus vetustissimus, B = Fragilaria sp., C = Navicula directa, D = Biddulphia reticulum. All 600x magnification. Photographs courtesy of Ron Hoenstine. Samples A and C from St. Johns County; samples B and D from Indian River County.
Figure 9. Petrified wood from a phosphate mine in southwestern Polk County. This cut and polished section shows near perfect preservation of the tree's original cellular structure through replacement by silica. Thomas M. Scott collection.
Figure 10. At upper right is a mammal tooth from a sinkhole exposed in a limestone mine, Citrus County. The fossil shark teeth are from a phosphate mine in south-central Florida: upper left, Hemipristis; center, Carcharodon; lower left, Carchirinus; lower right, Isurus. Note the “steak knife” serrations on the shark teeth. Thomas M. Scott Collection.
Figure 11. Casts and molds of fossil sea shells cemented together by clay and lime mud, Coosawhatchie Formation, from the Jacksonville area. Richard Johnson collection.
Many marine invertebrates, such as oysters, clams, echinoids, and corals, possess hard shells of calcite and/or aragonite. Aragonite is responsible for the "mother of pearl" luster of oyster shells. When one of these animals dies, its soft parts decay, but its hard shell may become covered with sediment. With the passage of time, a variety of chemical and physical processes can work on the shell and the surrounding matrix of sediment. As the sediment becomes cemented or compacted, the shell may be dissolved, leaving a hollow in the shape of the shell—a mold. If the mold shows the outside details of the shell, it is an external mold; if it shows the inside of the shell, it is an internal mold. If the mold becomes filled with sediment, it forms a cast.

The carbonate shells and bones of animals also can be replaced by quartz, resulting in "agatized" fossils. Agatized coral, with its blue and gray banding, is prized by collectors (Figure 12). Agatized mollusk shells may appear to be made of translucent glass.

**DISTRIBUTION OF ROCKS IN FLORIDA**

To anyone studying or collecting rocks and minerals, a knowledge of their modes of occurrence and associations is very helpful. The types and distribution of rocks that occur near the surface in Florida are shown on the maps in the appendix. It should be noted that much of Florida is covered by deposits of sands and clays that range from a few inches to several hundred feet thick. Therefore, a specific location on the map that shows limestone could be covered by a veneer of sand. It may be necessary to scout an area to discover places where a particular type of rock crops out at the surface.

**MINERALS**

A mineral is a naturally occurring substance with a characteristic internal structure determined by a regular arrangement of the atoms or ions within it, and with a chemical composition and physical properties that are either fixed or that vary within a definite range. This definition excludes all manufactured products, such as glass, cement, and steel. Also, a strict interpretation excludes synthetic rubies and diamonds, although they are chemically, structurally, and physically identical with their natural counterparts. Ice and snow are included by some mineralogists because they meet the criteria of the definition.

Many minerals occur as compounds, which are chemical combinations of two or more elements. Some "native elements," such as gold, silver, and copper often occur in their pure elemental state, uncombined with other elements. These elements are also minerals; however, none are known to occur in Florida.

**PHYSICAL PROPERTIES**

Each mineral is either an element or a chemical compound, each with a unique internal structure. The internal structure is determined by a
Figure 12. Agatized fossil coral, dredged from Tampa Bay. This specimen, which has been cut longitudinally, shows blue and gray banding on the cut edge and subtle zonations of blue, gray, and brown on the interior walls. Author’s collection.
regular arrangement of atoms or ions within it, which also determines its chemical and physical properties. All of these parameters are either fixed or may vary within a definite range. Although the physical properties of minerals may vary slightly, they are usually constant within narrow limits. Some diagnostic properties can be determined from a visual examination, and others from a few simple tests. The categories of physical properties given below (and in the Mineral Description section) are not meant to be all-inclusive, but they will be sufficient to identify common Florida minerals. For more information see a rock and mineral field guide.

Color is one of the most obvious physical properties. While some minerals are constant in color, many exhibit a range of colors due to impurities or variations in chemical composition. With practice one can become familiar with the more typical colors of minerals. A freshly broken surface should be used to determine color, because tarnish or weathering of an exposed surface usually alters normal color.

**STREAK**

Streak is the color of the residue produced by scratching a specimen on a white, porous porcelain plate (not glazed ceramic). Because streak color for a given mineral will be more consistent than the surface colors among specimens, streak is a better diagnostic technique than a visual estimate of color. Streak color may differ considerably from the specimen's color.

**HARDNESS**

The resistance of a mineral to scratching is an indication of its hardness. The Moh's hardness scale, below, is the standard system used by geologists to determine relative hardness of minerals. The scale goes from the softest (1, Talc) to the hardest (10, Diamond).

```
1. Talc
2. Gypsum
3. Calcite
4. Fluorite
5. Apatite
6. Feldspar (Orthoclase)
7. Quartz
8. Topaz or beryl
9. Corundum
10. Diamond
```

Most of the common Florida minerals have a hardness of 7 or less. Their hardness can be estimated using the following materials:

- Fingernail: 2 to 2.5
- Copper coin: up to 3
- Knife blade: up to 5.5
- Window glass: up to 5.5
- Steel file: 6 to 7

To determine the hardness of an unknown mineral, test to find out which of the minerals of known hardness it will just scratch; the unknown mineral is somewhat harder than that known mineral. A test from a smooth, clean surface or crystal face is best.
SPECIFIC GRAVITY

The specific gravity (SG) of a mineral is a number that expresses its weight compared to the weight of an equal volume of water. For example, the specific gravity of quartz is 2.65, which means that any given volume of quartz weighs 2.65 times as much as an equal volume of water.

FORM

The form of a mineral is the characteristic shape of its crystals. If minerals happen to grow in a favorable environment, most will form distinctive crystalline shapes. Crystals are regular geometric forms bounded by smooth, planar, crystal faces (Figure 13). Crystals often end in sharp, faceted ends, called terminations.

MINERAL DESCRIPTIONS

Many of the minerals that occur in Florida can be found as macro-specimens, that is, specimens large enough to examine without magnifying lenses. Except where noted, the following detailed descriptions of physical properties have been written for the identification of macro-specimens. These descriptions have been condensed into a Mineral Identification Table at the end of this section, to provide a convenient reference in the field. Mineral descriptions compiled from Bishop and Dee (1961) and Hurlbut (1963).
Figure 13. The crystal form of quartz, showing terminations and cross section. Drawing adapted from Hurlbut (1963). Crystals from the author's collection. Crystals are not from Florida, place of origin unknown.
ANHYDRITE  
(Figure 14)

COMPOSITION: CaSO₄, anhydrous calcium sulfate (see gypsum).  
COLOR: White, gray, brown.  
STREAK: White.  
HARDNESS: 3 to 3.5.  
SPECIFIC GRAVITY: 2.89 to 2.98  
FORM: Massive.  
OCCURRENCE: Found in Florida only from rocks that are deeply buried. It is often associated with gypsum.  
USE: Not commercially produced in Florida.  
REMARKS: Massive variety may resemble calcite or gypsum, but it is harder and has a higher specific gravity than both of them.

Figure 14. Anhydrite is the white mineral in this rock; the darker mineral is dolomite. This is a cut and polished section from a core taken during oil-test drilling in south Florida, on Key Largo. This core came from below 10,000 feet depth and is Lower Cretaceous in age. Author's collection.
ARAGONITE

COLOR: Colorless, white, yellow, various tints.
STREAK: White.
HARDNESS: 3.5 to 4.
FORM: The iridescent, pearly layer of many shells is aragonite.
OCCURRENCE: In shells, or associated with gypsum from deep wells.
USE: Not commercially produced in Florida, although some oolitic aragonite has been imported into Florida from the Bahamas as a raw material for cement production (U.S. Bureau of Mines, 1984).
REMARKS: Distinguished from calcite by its higher specific gravity and its lack of rhombohedral cleavage. It is harder than calcite.

CALCITE
(Figures 15, 16, 17)

COMPOSITION: CaCO$_3$, calcium carbonate.
COLOR: White or colorless; commonly various tints of yellow, orange, or gray.
STREAK: White or colorless.
HARDNESS: 2.5 to 3.
SPECIFIC GRAVITY: 2.72.
FORM: Over 300 massive to various crystal forms have been described. It readily breaks into rhombohedrons that resemble distorted cubes.
OCCURRENCE: Found throughout Florida, mainly as limestones. Crystalline forms usually found in voids in limestones. In caves it forms stalactites, stalagmites, and other varieties of travertine deposits, such as those at Marianna Caverns, Jackson County. Banded varieties result from changes in the types and amounts of dissolved minerals in the water that circulate through the host rock. Cleaner water, for example, tends to produce lighter colors, while dissolved iron minerals produce reds or oranges.
USE: See limestone.
REMARKS: Massive varieties can resemble dolomite, but calcite effervesces freely in cold hydrochloric acid, whereas dolomite does not. Dolomite is harder, 3.5 to 4.
Figure 15. Calcite crystals in a fan-shaped aggregate, showing well formed terminations. In Florida, calcite crystals usually form in cavities in limestone. Individual crystals can vary in size from microscopic to several inches long and wide. These crystals formed in a void in limestone, central Citrus County. Thomas M. Scott collection.
Figure 16. Massive form of calcite showing characteristic rhombohedral shape. Author's collection.
Figure 17. Stalactites are massive varieties of calcite, which result from precipitation in cavities of rocks or in caves. The circular, transverse, cut and polished section of a stalactite shows concentric rings. Each ring represents the addition of a layer of precipitated calcite. The longitudinal, cut and polished section of a stalactite shows a hollow, straw-like channel extending through its length. Water seeps out of a crack in a cavity's ceiling, runs down the internal tube, and drips off the end. In this way, stalagmites grow upward from the floor of a cave. These stalactites formed in a cavity in limestone, central Citrus County. Thomas M. Scott collection.
DOLOMITE

COMPOSITION: CaMg(CO₃)₂, calcium and magnesium carbonate.
COLOR: Various shades of gray or brown.
STREAK: White.
HARDNESS: 3.5 to 4.
SPECIFIC GRAVITY: 2.85.
FORM: Massive.
OCCURRENCE: Found throughout Florida, usually associated with limestone.
USE: Most of the dolomite produced in Florida is used for agricultural limes. Some dolomite is crushed and used for road surfacing.
REMARKS: Distinguished from limestone and calcite by poor reaction to cold hydrochloric acid and its hardness. It can precipitate directly from sea water where circulation is restricted and salinity is abnormally high, or limestone can alter to dolomite by the addition of magnesium ions. There is evidence that both processes have operated to produce various dolomites in Florida.

GYPSUM

COMPOSITION: CaSO₄ • 2H₂O, hydrous calcium sulfate. Anhydrite changes to gypsum by the absorption of water (see anhydrite).
COLOR: White to various shades of gray, yellow, brown.
STREAK: White.
HARDNESS: 2 (can be scratched with fingernail).
SPECIFIC GRAVITY: 2.32.
FORM: Massive or crystals.
OCCURRENCE: In Florida it is usually only found associated with anhydrite from deep wells. Bishop and Dee (1961) reported that small deposits of gypsum have been found at several localities: Sumter County (east-half of Section 23, T20S, R21E); Orange County (three miles east of Christmas at a depth of four feet); and in dredge spoils from the Gulf of Mexico and Tampa Bay in Pinellas, Pasco, and Hillsborough counties.
USE: A raw material for gypsum wallboard, and cement. Produced as a by-product of phosphate processing, but not sold commercially.
REMARKS: Its softness distinguishes it from anhydrite.
HEAVY MINERALS

Mineralogists have arbitrarily classified as “heavy minerals” certain minerals that have specific gravities greater than quartz (2.65). Species of heavy minerals found in Florida are: garnet, zircon, ilmenite, kyanite, leucoxene, monazite, rutile, sillimanite, staurolite, tourmaline, andalusite, pyroxene, corundum, spinel, and epidote. These minerals are disseminated throughout the sands of Florida, where they occur as small, rounded, sand-sized particles. Their tiny grain sizes mean that they can only be examined with a microscope or hand lens. Therefore, while detailed descriptions of the physical properties of macro-specimens have been omitted, the Mineral Identification Table does include their basic characteristics.

They generally comprise one percent or less of the total amounts of sand particles (Pirkle, et al., 1977). However, wind and wave action along shorelines tend to concentrate them, producing zones of higher percentages (Figure 18). Because most of them are dark colored (red-browns or black) they can be distinguished from the lighter colored quartz sand grains. Zircon is an exception in that it is usually colorless and glassy. Thin, dark bands of heavy minerals can be revealed by trenching across a beach.

Heavy mineral production in Florida is a multi-million dollar industry. At present, mining is only done in Clay and Bradford counties and is restricted to the Trail Ridge and Green Cove Springs deposits (Campbell, 1986). Trail Ridge is a prominent (up to 250 feet above sea level), north-south oriented, 130-mile-long sand ridge that begins in southern Georgia and extends approximately 40 miles into north Florida, ending in the southern parts of Clay and Bradford counties. This sand body is thought to represent a shoreline beach ridge created by an ancient, higher sea level (Pirkle, et al., 1977). This environment concentrated heavy minerals to such an extent that mining them is currently economical. Pirkle, et al. (1977) state that Trail Ridge sands contain an average of three percent heavy minerals, 45 percent of which are ilmenite, leucoxene, and rutile. Other heavy minerals of economic importance are staurolite, zircon, kyanite, sillimanite, and monazite.

Species of heavy minerals that occur in Florida sands, but which are of limited industrial and economic value include: garnet, tourmaline, spinel, andalusite, pyroxene, corundum, and epidote.

Ilmenite, leucoxene (an altered form of ilmenite), and rutile are known as “titanium minerals” because they are important sources of titanium metal. Because of its resistance to heat and corrosion, titanium is used in the aircraft, aerospace, and chemical industries. Titanium minerals are used to produce welding rod coatings and fluxes, carbides, stainless and heat-resistant steel alloys. Titanium dioxide (TiO₂) pigment, from ilmenite, is produced in greater quantities than any other white pigment. These pigments are used in the manufacturing of paper, paint, plastics, rubber, ink, and ceramics. In 1984 Florida was the only producer of rutile and one of two states with ilmenite shipments (U.S. Bureau of Mines, 1984).
Figure 18. Dark, heavy minerals concentrated in lighter, quartz beach sand, giving a salt-and-pepper appearance. Florida Geological Survey Collection.
Most zircon is used as foundry sands due to its resistance to heat. Its hardness makes it useful for sandblasting and polishing, and in ceramics, glazes and enamels. Zirconium-based chemicals are used in the paint, textile, and pharmaceutical industries. The aircraft and nuclear power industries use zirconium alloys. Florida was the only U.S. producer of zircon in 1984 (U.S. Bureau of Mines, 1984).

The aluminum silicate minerals, kyanite, sillimanite, and staurolite, are utilized as foundry sands, as additives for portland cement, and as ingredients in ceramic products. Florida was the only state reporting production of staurolite in 1984 (U.S. Bureau of Mines, 1984).

Monazite, a phosphate mineral of several rare-earth metals (cerium, lanthanum, yttrium, and thorium), is used primarily in petroleum catalysts, metallurgical alloys, ceramics and glass, electronics, nuclear energy, and lighting. Florida was the only state in 1984 that produced rare earths from mineral sands mining (U.S. Bureau of Mines, 1984).
LIMONITE
(Figure 19)

COMPOSITION: FeO(OH) • H₂O, brown hematite, bog-iron ore.
COLOR: Dark brown, orange-brown, yellowish-brown, black.
STREAK: Yellowish-brown.
HARDNESS: 1 to 5.5 depending on form and degree of consolidation.
SPECIFIC GRAVITY: 3.6 to 4.
FORM: Hard concretions or nodules; yellow ochre, which is soft, earthy
with varying amounts of clay minerals.
OCCURRENCE: Bishop and Dee (1961) reported that a deposit of
limonite exists near Chiefland, Levy County. They also reported a de-
posit of yellow ochre in Flagler County. Limonite gives rust-colored
stains to soils, limestones, and clays; in larger amounts it acts to cement
sand grains and clay particles into hardpans or concretionary forms.
USE: According to Bishop and Dee (1961) the deposit of bog-iron ore
near Chiefland was mined by the Confederacy to make cannon and
cannon balls; and the yellow ochre in Flagler County was mined until
1953 for paint pigment.
Figure 19. Limonite, showing typical forms of occurrence. From left to right: dark reddish-brown, smooth nodule; dark red, rough nodule with cemented sand grains; a tabular piece of sandy, limonitic hardpan. Florida Geological Survey Collection.
MICA

COMPOSITION: $\text{KAl}_3\text{Si}_3\text{O}_{10}(\text{OH})_2$, a complex aluminum silicate.
COLOR: White or translucent (muscovite), black (biotite).
STREAK: Colorless.
HARDNESS: 2 to 2.5
SPECIFIC GRAVITY: 2.76 to 3.1.
FORM: In its massive form mica occurs as foliated “books” that split apart easily, producing thin, flexible laminae.
OCCURRENCE: Found in Florida only as small, shiny detrital flakes in sands and clays.
USE: Fireproofing and insulating materials are its chief commercial uses. Not commercially produced in Florida.

PYRITE

COMPOSITION: $\text{FeS}_2$, iron sulfide.
COLOR: Yellow, brassy.
STREAK: Black.
HARDNESS: 6 to 6.5.
SPECIFIC GRAVITY: 5.02.
FORM: Cubic crystals with striated faces. Fresh specimens have a bright, brassy luster, hence its name of “fools gold.”
OCCURRENCE: From deep well cores in Florida. Bishop and Dee (1961) reported it had been found at one unspecified surface locality in Ocala. Found in some sediments in Florida as fine particles.
QUARTZ
(Figures 12, 13, 20)

COMPOSITION: $\text{SiO}_2$, silicon dioxide.
COLOR: May be any color due to impurities. Quartz sand is usually white or colorless, and may be rusty-stained by iron oxide coating, or black by organics.
STREAK: White.
HARDNESS: 7.
SPECIFIC GRAVITY: 2.65.
FORM: A great many forms of quartz exist. Crystalline forms often grow in cavities in limestone or dolomite, being elongated with six-sided (hexagonal) cross section and terminated in steep, pyramidal facets (Figure 13). Florida specimens are usually colorless, called rock crystal, while purple or violet crystals are called amethyst. An extremely fine-grained variety of chert or flint occurs as nodules, concretions, or as lining in cavities; banded varieties are called agate (Figure 20). Colors range from grays to bright shades of blue, red, yellow, and orange.
OCCURRENCE: Quartz sand is found throughout Florida. Crystalline, fine-grained or massive varieties are associated with limestone and dolomite through the State. In the western and northern counties, larger specimens can often be found along stream channels, especially those that have eroded deeply into limestone.
USE: Quartz sand is widely used in construction industries for road base and fill; major industrial uses are glass making and foundry sand. Good crystalline specimens are in demand by collectors. Colored or banded varieties can be made into semi-precious gemstones by cutting and polishing. Agatized coral is much desired by collectors; it is described in the Fossils section (Figure 12).
Figure 20. Chert, a variety of quartz, often occurs as nodules. This nodule has been broken to show the conchoidal fractures which produce razor-sharp edges, a property that was highly prized and utilized by primitive people to make projectile points and other stone tools. Florida Geological Survey Collection.
VIVIANITE
(Figures 21 and 22)

COMPOSITION: $\text{Fe}_3(\text{PO}_4) \cdot 8\text{H}_2\text{O}$, hydrous ferrous phosphate.
COLOR: Very dark blue or bluish-green. Crystals are clear when first exposed but change to blue after exposure.
STREAK: Grayish-blue.
HARDNESS: 1.5 to 2.
SPECIFIC GRAVITY: 2.58 to 2.68.
FORM: Usually in prismatic crystals, also in nodular, earthy forms.
OCCURRENCE: A rare mineral that has been found in some phosphate mines in central Florida.
USE: Not commercially produced in the United States.

Figure 21. Vivianite crystals in a phosphatic dolomite matrix, from a phosphate mine in Polk County. These bladed, very dark blue crystals have a metallic luster. Thomas M. Scott collection.
Figure 22. Vivianite crystals, transparent, very light blue-green. From a phosphate mine near Bartow, Polk County. Photo by A. Gricius, magnification approximately 18x.
WAVELLITE
(Figure 23)

COMPOSITION: \(\text{Al}_3(\text{OH})_3(\text{PO}_4)_2 \cdot 5\text{H}_2\)
COLOR: Translucent, white, yellow, green, brown.
STREAK: Colorless.
HARDNESS: 3.5 to 4.
SPECIFIC GRAVITY: 2.33.
FORM: Radiating aggregates, crystals rare.
OCCURRENCE: A rare mineral that has been found in some phosphate mines in central Florida.
USE: Not commercially produced in the United States.

Figure 23. Wavellite crystals in radiating aggregates. These are nearly colorless and transparent. From a phosphate mine near Bartow, Polk County. Photo by A. Gricius and D. Benke, magnification approximately 75x.
# Mineral Identification Table

Compiled from Bishop and Dee (1961) and Hurlbut (1963).

*Denotes heavy mineral species; found in Florida only as sand-size grains.

<table>
<thead>
<tr>
<th>MINERAL</th>
<th>COLOR</th>
<th>STREAK</th>
<th>HARDNESS</th>
<th>SPECIFIC GRAVITY</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anhydrite CaSO₄</td>
<td>white, gray</td>
<td>white</td>
<td>3-3.5</td>
<td>2.89-2.98</td>
<td>absorbs water and changes to gypsum over time</td>
</tr>
<tr>
<td>Aragonite CaCO₃</td>
<td>white, yellow</td>
<td>white</td>
<td>3-5.4</td>
<td>2.95</td>
<td>&quot;mother of pearl&quot; in shells</td>
</tr>
<tr>
<td>Calcite CaCO₃</td>
<td>white, gray, yellow</td>
<td>white</td>
<td>2.5-3</td>
<td>2.72</td>
<td>reacts with cold HCl acid</td>
</tr>
<tr>
<td>Dolomite CaMg(CO₃)₂</td>
<td>gray, brown</td>
<td>white</td>
<td>3.5-4</td>
<td>2.85</td>
<td>poor reaction with cold HCl acid</td>
</tr>
<tr>
<td>Francolite Ca₅F(PO₄)₃</td>
<td>green, blue, brown, violet, colorless</td>
<td>—</td>
<td>5</td>
<td>3.1</td>
<td>phosphate forming mineral</td>
</tr>
<tr>
<td>Garnet* (Ca,Cr,Fe,Mg,Mn,A1)(SiO₄)₃</td>
<td>red to black</td>
<td>—</td>
<td>6.5-7.5</td>
<td>3.5-4.3</td>
<td>Complex silicates of varying composition</td>
</tr>
<tr>
<td>Gypsum CaSO₄ • 2H₂O</td>
<td>white, gray, yellow, brown</td>
<td>white</td>
<td>2</td>
<td>2.32</td>
<td>see Anhydrite</td>
</tr>
<tr>
<td>Illite KAl₂(OH)₂AlSi₃(O,OH)₁₀</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>clay mineral</td>
</tr>
<tr>
<td>Ilmenite* FeTiO₃</td>
<td>—</td>
<td>—</td>
<td>5.5-6</td>
<td>4.7</td>
<td></td>
</tr>
<tr>
<td>Kaolinite Al₄(Si₄O₁₀)(OH₈)</td>
<td>white, gray</td>
<td>—</td>
<td>2-2.5</td>
<td>2.6</td>
<td>clay mineral</td>
</tr>
<tr>
<td>Kyanite* Al₂SiO₅</td>
<td>—</td>
<td>—</td>
<td>5-7</td>
<td>3.56-3.66</td>
<td></td>
</tr>
<tr>
<td>Mineral</td>
<td>Formula</td>
<td>Color</td>
<td>Hardness</td>
<td>Specific Gravity</td>
<td>Description</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------</td>
<td>------------------------</td>
<td>----------</td>
<td>------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Leucoxene</td>
<td>FeTiO₃</td>
<td>an altered form of ilmenite</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limonite</td>
<td>Fe₃O(OH) • H₂O</td>
<td>brown, yellow-brown</td>
<td>1-5.5</td>
<td>3.6-4</td>
<td>low grade “iron” ore</td>
</tr>
<tr>
<td>Mica</td>
<td>KAl₃Si₃O₁₀(OH)₂</td>
<td>white, black</td>
<td>2-2.5</td>
<td>2.76-3.1</td>
<td>platy, small, shiny flakes</td>
</tr>
<tr>
<td>Monazite*</td>
<td>(Ce,La,Y,Th)PO₄</td>
<td>yellowish to reddish-brown</td>
<td>5-5.5</td>
<td>5.0-5.3</td>
<td>phosphate of rare-earth metals</td>
</tr>
<tr>
<td>Montmorillonite*</td>
<td>(MgCa)O • Al₂O₃ • 5 SiO₂ • H₂O</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>clay mineral, “swelling clay”</td>
</tr>
<tr>
<td>Palygorskite</td>
<td>(Al,Mg)O • SiO₂ • H₂O</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>clay mineral (fuller’s earth)</td>
</tr>
<tr>
<td>Pyrite</td>
<td>FeS₂</td>
<td>yellow</td>
<td>6-6.5</td>
<td>5.02</td>
<td>“fools gold”</td>
</tr>
<tr>
<td>Quartz</td>
<td>SiO₂</td>
<td>white, varies</td>
<td>7</td>
<td>2.65</td>
<td>other forms = chert, opal, agate, flint, chalcedony</td>
</tr>
<tr>
<td>Rutile*</td>
<td>TiO₂</td>
<td>red to black</td>
<td>6-6.5</td>
<td>4.18-4.25</td>
<td></td>
</tr>
<tr>
<td>Sillimanite*</td>
<td>Al₂SiO₅</td>
<td>brown</td>
<td>6-7</td>
<td>3.23</td>
<td></td>
</tr>
<tr>
<td>Staurolite*</td>
<td>Fe₂Al₉O₁₇(SiO₄)₄(OH)</td>
<td>red to black</td>
<td>7-7.5</td>
<td>3.65-3.75</td>
<td></td>
</tr>
<tr>
<td>Tourmaline*</td>
<td>(Ca,Na,Al,Fe,Li,Mg)Al₆(BO₃)₃(Si₆O₁₈)(OH)₄</td>
<td>brown, black</td>
<td>7-7.5</td>
<td>3-3.25</td>
<td>complex silicate of varying composition</td>
</tr>
<tr>
<td>Vivianite</td>
<td>Fe₃(PO₄)₂ • 8H₂O</td>
<td>clear, turns dark blue on exposure to light</td>
<td>gray-blue</td>
<td>1.5-2</td>
<td>2.58-2.68</td>
</tr>
<tr>
<td>Wavellite*</td>
<td>Al₃(OH)₃(PO₄)₂ • 5H₂O</td>
<td>white, yellow</td>
<td>colorless</td>
<td>3.5-4</td>
<td>2.33</td>
</tr>
<tr>
<td>Zircon*</td>
<td>ZrSiO₄</td>
<td>colorless</td>
<td>7.5</td>
<td>4.68</td>
<td>glassy</td>
</tr>
</tbody>
</table>


AGATE: A banded, colored variety of silica (quartz).

AGGREGATE: Composed of a mixture of substances (minerals and rocks) separable by mechanical means.

AMORPHOUS: Without form; applied to rocks and minerals having no definite crystalline structure.

CHERT: A dense sedimentary rock consisting of microscopic particles of silica (quartz). Occurs in layers and as isolated masses.

CONCRETION: A nodular or irregular concentration of minerals formed by localized deposition of material from solution, generally about a central nucleus. Harder than surrounding rock. Examples are clay and ironstone nodules.

CORAL: A tiny, bottom-dwelling marine animal that secretes an external skeleton of calcium carbonate. Some are solitary but most grow in colonies. The calcareous skeleton of a coral or group or colony of corals.

CRYPTOCRYSTALLINE: Crystalline, but so fine grained that the individual components cannot be seen with a magnifying glass.

DETRITAL DEPOSITS: (Clastic) Fragments of rocks that have been transported from their place of origin to the place of deposition.

ECHINOID: Free-moving, marine invertebrate animals with external skeletons of calcium carbonate. Bodies range from spherical to flattened disc-like forms; many have spines. Examples are sea urchins and sand dollars.

ELEMENT: A substance that cannot be decomposed into other substances.

EROSION: The natural processes of weathering, disintegration, dissolving, and removal of rock and earth material, mainly by water and wind.

EFFERVESCE: To bubble and hiss, as limestone when acid is poured on it.

FLINT: A dense sedimentary rock consisting of microscopic particles of silica (quartz). Occurs in layers and as isolated masses. Also called chert.

FORAMINIFERA: One-celled animals, mostly of microscopic size, that secrete shells of calcium carbonate, or build them of cemented sedi-
mentary grains, consisting of one to many chambers arranged in a great variety of ways. Most are marine, but some live in fresh water.

FOSSIL: Remains or traces of plants or animals which have been preserved by natural causes in the earth's crust.

HYDROUS, HYDRATED: A compound formed by the union of water with some other substance. Containing water chemically combined.

INTERBEDDED: Occurring between beds, or lying in a bed parallel to other beds of a different material.

IRIDESCENCE: The exhibition of colored reflections from the surface of a mineral; a play of colors, as from the pearly layer of sea shells.

MACROCRYSTALLINE: A textural term applied to rocks in which the constituents are distinguished with the naked eye.

MARINE: Refers to sediments deposited in sea water, or to animals that live in the sea.

MOLLUSKS: A large group of invertebrate animals, both marine and fresh water and land. Many secrete external shells or internal structures of calcium carbonate; examples are oysters, clams, squid, snails.

NODULES, NODULAR: A general term for rounded concretionary bodies, which can be separated as discrete masses from the formation in which they occur.

OUTCROP: That part of a stratum of rocks which appears at the surface. To crop out.

STALACTITES: Conical or cylindrical deposits of minerals, usually calcite or aragonite, hanging from the roof of a cavern.

STALAGMITES: Columns or ridges of carbonate rock rising from a limestone cave floor, and formed by water charged with calcium carbonate dripping from the stalactites above. Stalactites and stalagmites often meet, forming a column from floor to ceiling.
APPENDIX

These maps are modified from the Bureau of Geology’s Environmental Geology Map Series. The color Environmental Map Series maps show more detailed lithology because of their larger size (22" x 34", at a scale of 1:250,000). Maps from this series may be ordered by remitting $1.00 for each map; check or money order must accompany all requests for maps, made payable to “Florida Bureau of Geology.” Specify maps wanted, for example: Map Series 85, Orlando Sheet. Send orders to:

Florida Bureau of Geology
903 West Tennessee St.
Tallahassee, FL 32304-7795
This map is meant as a general guide to surface lithology. Each area outlined on the map may consist of more than one kind of seabedface sediment.

Gravel and Coarse Sand

Limestone

Medium-Fine Sand and Silt

Clayey Sand

Dolomite

Shell Beds

Sandy Clay

Lake

Modified from Schmidt, 1979, Map Series 90, Tallahassee Sheet.
This map is meant as a general guide to surface lithology. Each area outlined on the map may consist of more than one kind of subsurface sediment.


Map Sheet.

...Clayey Sand

Limestone ~ Dolomite

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All barrier islands are shelly sand and clay lithology.
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- Shelly Sand and Clay
- Peat
- Limestone
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All barrier islands are shelly sand and clay lithology.

Legend:
- Sandy Clay
- Clayey Sand
- Limestone
- Limestone/Dolomite
- Shelly Sand and Clay
- Medium Fine Sand and Silt

Modified from Knapp, 1982, Map Series 97, Tampa Sheet.
This map is meant as a general guide to surface lithology. Each area outlined on the map may consist of more than one kind of subsurface sediment.

- **Medium Fine Sand and Silt**
- **Clayey Sand**
- **Limestone**
- **Dolomite**

This map is meant as a general guide to surface lithology. Each area outlined on the map may consist of more than one kind of subsurface sediments.
