



VI.

GEOLOGY.

THE geology of Florida is full of interest, mainly prospective, although no general survey has yet been made. Dr. J. Kost, the first and present State Geologist, has issued one report of results, and the public await with profound interest the further prosecution of the work. A preliminary inspection is all that has been thus far accomplished, but that has afforded glimpses of rich treasures in the fields of both mineralogy and paleontology. Dr. Kost finds the geological formations of Florida to be "the equivalent of the Tertiaries of the Paris basin in France and the vale of the Thames in England." He reports fossil remains, not only of the mastodon, zeuglodon, and carcharodon, but also of the rhinoceros, hippopotamus, llama, peccary, leopard, tiger, hyena, lion, camel, and elephant; and "a species of bimana." One of the three mastodon skeletons found is of exceptional size and will be

set up for the State Museum; and it will be " the largest one of a mastodon on record; and, next to that of the whale, the largest known of any animal."

The mineralogical scope is also considerable. Dr. Kost finds lime, iron, and sulphur widely distributed ; with silicon galore, and potassium, sodium, magnesium, aluminum, and phosphorus. Other authorities report lead. Agates of chalcedony and opal are reported as found near Tampa.

Nothing has been discovered, it appears, lower than the Tertiary period; but this is abundantly and fully represented in all its subdivisions. The Eocene is of considerable depth; the Miocene and the Pleiocene, less; while over nearly all lies a heavy spread of Pleistocene or Post-tertiary.

The doctors disagree sadly as to the formative agencies that made this peninsula and their processes. Some years ago, such men as Agassiz and Joseph Le Conte, after examining the Atlantic side, told us that this southward-pointing land was underbuilt by corals and upraised in successive tiers. Later, Heilprin explored the Gulf coast, and failed to find any confirmation of the coral-reef theory. He confidently asserts : " On the contrary, the existence of the heavy fossiliferous deposits about Tampa, on the Manatee, along the tributaries of the

Big and the Little Sarasota Bays, and more particularly those exposed on the Caloosahatchee, conclusively proves that a coral extension to the Southern United States, such as has been theoretically set forth, does not exist in fact." Of the coral, he maintains, the structure is limited and local. Dr. Kost thinks it almost absurd to venture upon any statements concerning the principles of the geological formation of the State. He adds, however, that when the Eocene rocks were in course of deposit, the Tertiary was reposing at the bottom of the sea, from one hundred to several hundred feet deep, and was, for a time at least, sinking slowly—that is, at a pace correspondent to the continuous building of coral reefs. This Eocene deposit, though new geologically, is in secular chronology very old, because it dates back to a time anterior to the upheaval of the lower half of the Rocky Mountains. In course of time, the bottom of the sea began to rise, at first slowly. During this period occurred the Oligocene deposits. Later, the dry land appeared, and the Miocene deposits were made; and, in the after-age, the land was submerged again, the submergence embracing not only Florida but also Alabama, Mississippi, and Louisiana, and parts of Tennessee, Arkansas, and Texas—the whole to

emerge a second time, and to rise to its present level. The State Geologist finds, further, that "an extensive anticlinal, of an axis parallel **with** that of the peninsula, trends centrally through the peninsula." There are to-day indications, especially on the eastern side, of a rise of the land now in progress. Dr. J. **Dabney** Palmer finds the origin of this peninsula in the changes wrought by the "rise of the Appalachian Mountains," which diverted the Gulf Stream from its former channel up the Mississippi **Valley**. This caused an eddy south of the then land; and sand-bars resulted and sediment and coral insects followed. "And thus it has been going on for ages—sand-bar and deposit, and coral reef. And thus the building and extension of the peninsula continue to this day. The gradual upheaval of the land has lifted the northern and central portions of the peninsula far above the sea-level. This elevation will probably increase, and the Everglades become dry, even if not assisted by artificial means. The digging of wells, etc., has disclosed this great variety of formations throughout the State. It is not infrequent that as beautiful deposits of coral are disclosed high up in the peninsula and Northern Florida as are to be found on the reefs south of Cape Sable. Should these causes

continue, the deep channel of the Gulf Stream may be closed, Cuba annexed by natural causes, the valley of the Mississippi be extended, and the Gulf of Mexico become a fertile plain." The indications, along both the Atlantic and the Gulf side, are confirmatory of the theory that the land is still rising slowly—more slowly, it is confidently believed, than the operations of the Atlantic Coast and Canal Company's dredging corps.

Industrial Features. — The industrial arts find some valuable mineral deposits among these *rock* materials. Dr. Kost states that several localities have been found to have large deposits of rich phosphates, deposits quite as rich in phosphoric acid as are the phosphate rocks on Cooper and Ashley Eivers in South Carolina, from which immense revenue has been derived. These Florida beds show phosphates of lime, of silica, of alumina, and of iron. They are indicated by phosphoric-acid-bearing rocks in the counties of "Wakulla, Alachua, Marion, Hillsborough, and Manatee. In Wakulla the State Geologist finds a triple phosphate of lime, iron, and alumina, indicating exceedingly valuable beds, the samples analyzed showing in one instance 23.85 per cent in phosphoric acid, equivalent to 59.05 per cent bone phosphate of lime ($\text{Ca}_3\text{P}_2\text{O}_8$).

Shell marl of marine deposit is found in nearly all parts of the State, and inexhaustible fertilizing marl-beds underlie the soil almost everywhere.

Limestone is to be found in nearly all parts of the State; a large proportion of which, however, will not yield a first quality of lime. The rock is generally too silicious, and slacks poorly; yet Professor **Pickel**, of the State College, found by analysis 93.67 of carbonate of lime, being equivalent to 52.46 per cent of quicklime.

Clays exist, especially in Northern Florida, of which passably good bricks are made; but the presence of too much either of lime or of sand often prevents the best results in this direction. Clays sufficiently fine and pure for pottery are to be seen at various points, in lower strata, where coarser varieties occur.

Kaolin has been found in numerous localities; but thus far little is known of its quality or quantity.

Iron-ore is found in Northern Florida, and in Jackson County a "rather extensive deposit" is reported; but nobody seems to believe that it exists anywhere in paying quantities. The ore is of the limonite variety, and is not the best. It is to be found in all parts of the State. There are several

chalybeate springs whose medicinal qualities have been tested. Dr. Kost thinks that a large proportion of the running water of wells and springs is of the chalybeate character; in springs and wells these are commonly called *sulphur-waters*, because of the presence of sulphureted hydrogen occasioned by chemical action. .Nearly all the clays are stained by "oxides of iron."

Coal is present. Lignite has been unearthed in Northern **Florida**. Dr. Kost discovered, in Santa Rosa County, a vein about thirty inches thick. This Tertiary coal is similar to that found along the Northern Pacific Railroad and used on that road. An artesian well, sunk during the present year in Marion County, it is stated, passed through a vein of coal some fifteen to eighteen feet thick, at a depth of nearly six hundred feet.

Limestone, quarried for building purposes, exists in Northern Florida. It is, however, for the most part, soft, porous, and liable to imbibe moisture; but the Union Bank building at Marianna, in Jackson County, built of this material, has stood now some forty years, and is to-day in a good state of preservation. Chimneys are frequently built of it. It has been pretty extensively used in Hernando County for both building-walls and chimneys.



Flint-rock is available for rough walls, and will last till the end of time. This is found as far south as Sumter County, in **Semi-tropical** Florida. Arrow-heads, spear-points, and rude knives were made of this flint by the Indians or their predecessors. In Northern Florida it abounds along the line of the railroad in Suwannee and Alachua Counties. Dr. Kost says: "This rock was evidently deposited from solution by presence of lime and potash, with the silica in the waters of the later Tertiary, as the shell remains of the echinoidea, pecten, etc., appear with their own shell tissue, often in full integrity."

Sandstone occurs in many places. It is soft, its cementing principle being impaired "by diffusion of aluminous materials previously oxidized."

Marble, of stalactite and stalagmite varieties, is to be found in the caves of Jackson County and some other localities. Ceilings, floors, and walls of the caves are covered with this marble. It is in some instances beautifully white and translucent.

Coquina—a shell limestone, as the name implies—exists in many places along the Atlantic coast. The texture of the rock, Dr. Kost writes, is very interesting, from the integrity of the *shell* material. It dresses moderately well, leaving a corru-

gated surface of rather agreeable aspect. It is very durable, as is proved by the integrity of the walls of St. Augustine, those of the old Spanish Fort San Marco, and of the old cathedral at the same place—some of these a matter of two centuries old.

Coralline is abundant, especially on the Atlantic coast south of the coquina region.

But concrete—of sand, shells, and lime or, better, cement—is more easily managed than either coquina or coralline, cheaper, and doubtless equally durable; so that its use is likely to supersede both the other hitherto favorite building materials. It has been used extensively in several places, notably at Cedar Keys; and, more recently, in a modified form in the erection of the palatial hotels at St. Augustine.

Mineral Waters—The great variety and abundance of mineral deposits in Florida naturally give numerous mineral springs. The mineral waters are in the main solutions of lime, alumina, and iron; but magnesia, soda, sulphur, and potash occur frequently, and iodine and bromine somewhat rarely. Ponce de Leon's Fountain of Perpetual Youth has been discovered a score of times, pretty much all over the State, and the modern wonder is that that grandiose *Adelantado* himself could not find it,

when it is so numerous to-day. Among the mineral springs conspicuous are the Newport Springs, on St. Mark's River, in **Wakulla** County; the Hampton Springs, of Taylor County; the White Sulphur Springs, of Hamilton County; the Suwannee Springs, of Suwannee County; and the Green Cove Springs, of Clay County.

Soils.—The soils are usually classed as first, second, and third rate pine or sand lands, high and low hammocks, and swamp lands.

Of the pine lands Dr. Kost says : " The sand deposits of Florida lands are very generally misjudged. They are generally estimated by the tourist by what he has been conversant with in deposits of ' sand-banks' in Northern localities, distant from the sea, which are generally wind-drifts or drifts from fresh-water bays or lakes, and the sand is quite liable to be clean and free from earthy or saline mixture. But here in Florida the accumulations are from salt-water bays or sea-coasts, and they are never free from marine salts, or more especially having the presence of the dust of marine shells, in the form of carbonate of lime from organic forms or shells of mollusca. Hence the sands of Florida are far more productive as compared to others than are those not of recent marine derivation. It happens,

therefore, that tourists who have opportunity to inspect growing crops on the '*sandy barrens*' are not a little astonished to see respectably good crops grown on such lands. Similar sand deposits elsewhere—that is, in the adverse circumstances—commonly are found to be almost completely barren." Humus is the general need of the sand lands.

Hammocks may be defined as hard-wood lands, the high being either alluvial or clay, the low being of infinite variety both as to wetness and to material.

Swamps are either sand or low hammocks in process of formation.

Drainage.—Germane to the matter of soils is the reclaiming of lands. In Subtropical Florida especially there is much overflowed land, and a drainage company has undertaken to reclaim lands on shares around Okeechobee as a center. Here are, it is estimated, about eight million acres of water-covered land—Lake Okeechobee, of a thousand square miles, and the Everglades, more than ten times that area. The company began operations in 1881. In 1887 the Legislature sent a committee to examine and report results. They first visited Lake East Tohopekaliga, and their report states: "We find the lake eight feet two inches below its original level, with a handsome beach of firm white sand



three or four **hundred** feet wide, hard and level, where formerly was seven or eight feet of water. We find the surrounding marshes and cypress swamps are dry and ready for the plow. . . . All these lands are in the highest state of cultivation, with handsome crops of sugar-cane, corn, potatoes, and various vegetables, all vigorous and thrifty. The lands are exceedingly fertile, and though but recently freed from two to four feet of standing water, are now dry and fit for all crops of a temperate or subtropical climate. . . . Sixty-five tons of cane, seventy bushels of corn, seventy bushels of rice, have been raised per acre on these lands."

All this is *en couleur de rose* certainly.

Toward the draining of Okeechobee directly the Drainage Company cut one canal forty-six feet wide and ten feet deep from the lake connecting it with the Caloosahatchee River, which flows into the Gulf of Mexico. The company seems to have published no report of recent results of this part of its work; but Mr. John B. Hickey, of Fort Myers, on the Caloosahatchee River, writes that Lake Okeechobee is now three feet below its normal level. The immediate friends of this enterprise appear very hopeful of early and complete success. Many others are less hopeful. As Okeechobee is 20*44

feet above sea-level, and as the Everglades-level at Lake Worth is sixteen feet above that lake, and as the Everglades-level at Miami is 55 feet above that of Biscayne Bay, it does not seem impossible **that** at least a great part of these Everglades waters may be drained off. It seems to be a question mainly of canal capacity.

Writers on **hygiene** maintain that the conditions above given—removal of water from extensive areas of rich alluvial lands and cultivation of the same—must evolve malaria. The healthfulness of this reclaimed region, however, is vouched for, at least for the first four years of the Drainage Company's operations—up to 1885—as appears in its report quoted elsewhere in these pages in treating of malaria. It kept nearly forty white men at work summer and winter for three or four years, and had not a single case of malarial fever. This report goes far to prove that malaria is not as prevalent as is popularly believed, at least in that Everglade-lake region. What future developments are to bring forth remains to be seen; and it is possible that these very operations may change things in that regard; but, to-day, assuredly there is no great reason to be alarmed about malaria. A very few more years of draining will settle that question.