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NATURAL RESOURCES OF GEORGIA

Prepared by the State
Department of Natural Resources in Co-operation
with the State Department of Education

for the

GEORGIA PROGRAM FOR THE
IMPROVEMENT OF INSTRUCTION

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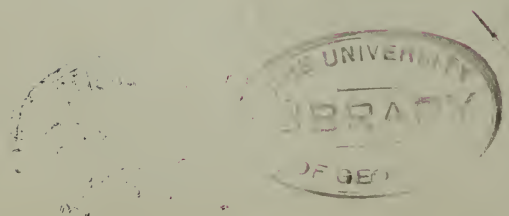
M. E. THOMPSON,
Director

PAUL R. MORROW,
Director of Research

CELIA C. MCCALL, *Assistant*
Director of Research

•

State Department of Education
M. D. COLLINS
State Superintendent of Schools
Atlanta



FOREWORD

This publication of the Georgia Program for the Improvement of Instruction in the Public Schools is aimed to meet the specific need for materials to use in the state high school course, Natural Resources of Georgia, which was approved by the State Board of Education, May 29, 1937.

The contents of this bulletin will be useful also to the many teachers of the state who are now making the effort to conduct school programs based upon the needs and problems of Georgia.

This bulletin has been made possible by the very fine co-operation of the State Department of Natural Resources with the State Department of Education in preparation of the factual materials on the natural resources of the state.

Special credit is due to Governor E. D. Rivers, and to Commissioner R. F. Burch of the State Department of Natural Resources, for their leadership and inspiration in this undertaking.

Mr. C. A. Whittle, Educational Manager of the Division of Forestry in the Department of Natural Resources, has rendered most valuable assistance in preparation of the manuscript for the printer.

M. D. COLLINS,
State Superintendent of Schools

S. V. SANFORD,
Chancellor of the University System of Georgia

State Department of Natural Resources

R. F. BURCH, *Commissioner.*

FRANK HEYWARD, *Director of the Division of Forestry.*

CAPTAIN GARLAND PEYTON, *Director of the Division of Mines, Mining and Geology.*

CHARLES N. ELLIOTT, *Director of the Division of State Parks, Historic Sites and Monuments.*

JOE D. MITCHELL, *Director of the Division of Wild Life.*

GENERAL TABLE OF CONTENTS

INTRODUCTION

This publication has been prepared to provide information on which to base a course of study treating of natural resources of Georgia.

The State Superintendent of Schools, Dr. M. D. Collins, and the State Board of Education are entitled to high commendation for setting up a course of study to give young Georgians information about the natural resources with which they must deal in making a living; in other words, this is a forward step in teaching Georgians about Georgia's environment to the end that they may be more usefully adjusted thereto.

Georgia has vast and varied resources, none of which has been fully developed. Its forest resources can be easily doubled. Its mineral resources in many respects have scarcely been scratched. Its wild life, including useful wild animals, birds and fish, can be greatly increased. The state contributes in many ways to the physical and mental well-being of its citizens, with the Department of Natural Resources providing parks for recreation and marking historic sites and monuments for inspiration—an undertaking that has barely got under way.

The Act of the State General Assembly in 1937, creating the Department of Natural Resources, states that the general purposes of the department are as follows:

"1. To take over the powers, duties and authority exercised by the Department of Game and Fish, the Department of Forestry and Geological Development, the Commission of Forestry and Geological Development, and establish the Division of State Parks, Historic Sites and Monuments.

"2. By investigation, recommendation, and publication ,to aid:

"(a) In the promotion of the conservation and development of the natural resources of the state.

"(b) In the promoting a more profitable use of lands, forests and waters.

"(c) In promoting the development of commerce and industry.

"(d) In co-ordinating existing scientific investigations and other related agencies, in formulating and promoting sound policies of conservation and development.

"(e) To collect and classify the facts derived from such investigations and from other agencies of the state as a source of information accessible to the citizens of the state, and to the public generally, setting forth the natural, economic, industrial and commercial advantages of the state.

"(f) To establish and maintain perfect co-ordination between this Department and all of its Sub-divisions and with any and every agency of the Federal Government interested in or dealing with the subject matter of such Department or Sub-division."

The four divisions of the Department of Natural Resources are as follows:

Division of Forestry.

Division of Wild Life.

Division of Mines, Mining and Geology.

Division of State Parks, Historic Sites and Monuments.

Each of these divisions has gladly contributed to this publication.

STATE MUSEUM. The State Museum, under the supervision of the Department of Natural Resources, has an excellent display of the state's natural resources on the fourth floor of the State Capitol. A curator in charge will gladly explain to visiting teachers or students the important features of the various displays of minerals, wild life, and forest products. Many teachers are availing themselves of the opportunity of visiting the museum to learn more about the resources of the state, and all teachers and students are welcome to do the same.

NATURAL RESOURCE RESERVES. The state is acquiring, through donations of counties, areas of 1,000 acres or more to be developed by the Department of Natural Resources. These tracts will be used

as reserves where game and fish will be propagated and protected, and as demonstrations in forestry practices.

Provisions will be made for outings and recreation to accommodate those who decide to visit and study conservation practices and to enjoy the pleasures the areas provide. A start has been made in acquiring these reserves which, when established and in operation, will prove of great value as places where teachers can take their pupils to study forestry and wild life.

R. F. BURCH, *Commissioner,*
Department of Natural Resources.

STATE PARKS OF GEORGIA

Prepared by

The Division of State Parks

Historic Sites and Monuments

OF THE

Department of Natural Resources

State Parks of Georgia

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SPECIAL TABLE OF CONTENTS

State Parks of Georgia

INTRODUCTION

There was a time in the history of our nation when that portion of the South now known as Georgia was a land of unbroken forests, known only to prehistoric races and to the creatures of the wilderness. From the coast and coastal islands to the highlands of Coosa and Itawa no white man had left his mark upon the soil. The valleys were deep and rich, the hill tops virgin and wild.

Centuries have seen the creation and growth of a new empire out of this wilderness—not a mushroom growth, but the slow unvarying march of a civilization which would not be stemmed or checked. Within the course of that progress great and courageous men have lived. Blood has been shed; cities have flourished and disappeared under the heel of time. All have made a contribution to the building of a nation. Today, three million people live and work and play through that once vast wilderness. Cities have grown out of the hills and plains. Fertile valleys and pasture lands lie everywhere; open wooded slopes are dotted with farm houses, the vanguard of a still progressive civilization. Ribbons of steel and concrete highways have appeared to take the place of those first arteries of commerce, the rivers. Droning new ships in the skyways are proof that we have not turned backward, or ceased to grow.

Today, a new vision has appeared on the horizon. There were certain public-spirited men in this generation who realized that unless some action was taken our forests would soon be gone, who recognized that there were certain individuals who made fortunes by exploitation of nature, by robbing the earth of its forest trees, and the soil of its fertility. Through them, over a long period of years, game laws have come into existence, national and state forests have appeared as a basis for a perpetual timber supply, and many of the beauty spots, remnants of those wilderness areas first seen by the founders of our state, saved. Those beauty spots, bought by a few public-spirited men and women and deeded to the ownership of the public have become our national and state parks.

While conservation is the first and primary reason behind the establishment of our original state and national playgrounds, they have also been preserved to commemorate some hallowed or historic site, or to honor some great man who served his country in a magnificent way. They are often made into playgrounds to serve some section of the state or nation.

Although several historic and beauty spots of Georgia had been chosen as state park sites, and were under development by the National Park Service through the aid of the Civilian Conservation Corps, it was not until 1937 that the Georgia State Legislature created a new division of state government whose sole duties consisted of operating and maintaining a park system. This new branch of state government, designated the Division of State Parks, under the Department of Natural Resourses, was charged with the responsibility for several activities.

First, was the development of the parks in existence. On the historic parks were established small museums, picnic areas, parking areas, and all conveniences for those persons who wished to see that type of park. Only conveniences, however, were built and all attempts were made to avoid cheapening the glamour and glory that belong to another age. In the recreational and scenic areas, the developments were more elaborate. At many of those areas, through the National Park Service and the Civilian Conservation Corps, lakes for boating, swimming and fishing were constructed; cabins, inns, trails, bridle paths, large picnic areas, with outdoor fireplaces, tables, benches—all were built in an attempt to provide every facility to make visitors comfortable.

Second, came the acquisition of new state park lands in those sections of the state where parks did not exist. The ultimate aim was to provide recreational areas which would be available to every man, woman and child in the state, and within the reach of every visitor to Georgia.

Third, was to list and mark both the prehistoric and historic spots of Georgia in order that students and others interested in Georgia's history could learn more about the unusual and interesting historic background of this state.

In spite of all developments on state parks, the major portion of the areas are kept in virgin wilderness, where not even a trail penetrates, where the trees, the flowers, the forest floor and the wilderness creatures are just as they were the day they were made. Those spots are not advertised. It is the wish of the Division of State Parks that visitors discover them and recognize in them their true worth and value.

The Division of State Parks is also sponsor for three recreational demonstration projects being developed by the National Park Service. These three areas, at Crawfordville, in Taliaferro County; near Rutledge, in Morgan County; and at Pine Mountain in Harris County, are to serve as playgrounds for organized groups. There the children

who play throughout the summer months on crowded city streets, and who would not otherwise have an opportunity to visit the woods, fields and streams of Georgia, will be given a two weeks camp during the summer months, will be taught organized play, organized work and some of the essential elements of social behavior.

The Division is also co-operating with the Vocational Division of the State Department of Education in the erection of a Future Farmers' Vocational Camp in Newton County. To this camp each summer will come thousands of boys from all over the state for a week or two weeks in the out-of-doors.

In addition to its recreational and camp program, the Division of State Parks has undertaken the task of acquiring data on all historic sites already marked, and in further carrying on the program of marking historic sites in the state of Georgia. After the survey has been completed, a map and bulletin will be issued, locating and giving a brief description of each important site.

Georgia has nine state parks at present. These are distributed widely throughout the state from the tidal flats at the mouth of the Altamaha River on the coast to the top of the Blue Ridge at the northern boundary of the state.

VOGEL STATE PARK

Opinions have been expressed that this section of the Blue Ridge is not unlike the soft, blending landscape of the highlands of Scotland. The Appalachian Trail, that blazes a marked foot-trail which extends from Mt. Oglethorpe in Georgia to Mt. Katahdin in Maine and is over two thousand miles in length, runs through Vogel State Park. Visitors to the park area are sometimes a little startled to see a lone hiker or a group of two or three hikers, their clothes wet with perspiration, carrying a pack, come down the trail out of the mountains, pause for a drink at the fountain in the gap and go trudging up the trail into the wilderness beyond. Many of these hikers, weary from nights of sleeping on the ground, stop for a night in the inn or in one of the recently constructed cabins at Vogel Park.

Vogel State Park and its surrounding forests, both private and those within the boundry of the Chattahoochee National Forest, have an abundance of game. Squirrels, wild turkeys and rabbits may be found on the mountain slopes. Quail are abundant in the open valleys. A few years ago, the Cherokee Game Refuge, over twenty thousand acres in extent, was established near Hightower Gap, some twelve miles from the park. Deer were placed on the refuge, and

during the years which have elapsed since its establishment have spread into the surrounding valleys and on to the adjoining mountain slopes. Today a keen observer may see one of those wary animals on the wilder portions of the park, just as he may at any time stumble into a flock of wild turkeys, feeding on acorns or chestnuts from the few remaining chestnut trees which have thus far escaped the blight. Recently several deer were turned loose in the Chattahoochee National Forest. Fishermen have already reported seeing these picturesque and interesting animals. Perhaps in a few years one may be assured, on visiting Vogel Park and its environs, of finding a primitive state of nature and mountain wilderness unexcelled in the Southeast.

The gap at this park occupies a strategic position in that part of American history which recalls the irresistible advance of the white man's frontier upon the diminishing hunting grounds of the American Indian. No tribe made nobler efforts to hold their land against this advance than did the Cherokee in seeking to retain their mountain homeland. Voluntary cessions were made until the tribe had receded behind a certain line, and upon this boundary they made their last stand. Two great natural features mark this line—the waters of the Chattahoochee and the Blue Ridge Mountains. Where the two meet at the head of the Chestatee, easternmost headwater of the Chattahoochee, lies Neel (Frogtown) Gap. To this gap, in 1819, a line was surveyed to mark the connection between the two great natural features forming the Cherokee boundry. Upon this line today stands Vogel State Park.

Behind this boundary the Cherokee developed a civilization with a rapidity that has been a wonder of history. The Cherokee, Sequoyah, invented an alphabet by which the majority of his tribe learned to read and write within a few months. A tribal newspaper was published; the Bible was translated and printed in the Cherokee language. Courts were established, and after forming a Constitutional government, modeled after that of the United States, the tribe declared that this boundary set off the Cherokee nation which they declared to be one of the independent nations of the earth.

This advance in civilization gained the admiration of the world, but failed to save the Cherokee homeland. The white man took possession of the land. In 1838, the tribe reluctantly turned its face toward the setting sun as it was removed to the Indian Territory west of the Mississippi.

The advancing frontier proved triumphant over the Cherokee homeland. The native inhabitants removed, frontier vigor was di-

BLOOD MOUNTAIN GORGE SEEN FROM PARK

OF SEVERAL WATER-FALLS IN PARK

HOME OF PARK SUPERINTENDENT

WELCOME INN AT NEEL GAP

VOGEL STATE PARK

LAKE WITH BATHING AND BOATING FACILITIES

rected toward pushing back the wilderness, so that man's industry might rise in its place. Trees and game fell before the advance. The "Song of the Chattahoochee" became a dirge. At the end of almost a century of exploitation, it has become evident that natural conditions must be preserved and restored, in order that the land of the Cherokee may continue to be of value to the state.

Near the turn of the century, the Pfister Vogel Leather Company of Milwaukee bought almost 65,000 acres of land around what is now Vogel State Park. The forests of this land were acquired to supply tanbark and tanwood for the leather plant in Milwaukee, but shortly after the area was purchased, a synthetic tannic acid was developed and the Blue Ridge Mountain forests were never destroyed. Shortly after 1927, the Vogel brothers donated two hundred and forty-eight acres of land to the state of Georgia as a state park, and the park itself was named after them as an acknowledgement of their generosity.

In 1933, a Civilian Conservation Corps camp was established near the park property. Over a period of several years, picnic areas were developed, a stone inn constructed at Neel Gap, a beautiful forty-acre lake and trails, cabins, bathing and picnicking facilities provided, making this area one of the outstanding recreational state parks in the northern part of Georgia.

In Vogel State Park, many summer visitors find relief in the cool, mountain breezes. They enjoy a vacation with swimming, fishing, hiking and many related outdoor activities in this land of scenic splendor, the last frontier of the Cherokee nation and the new conservation frontier of the South.

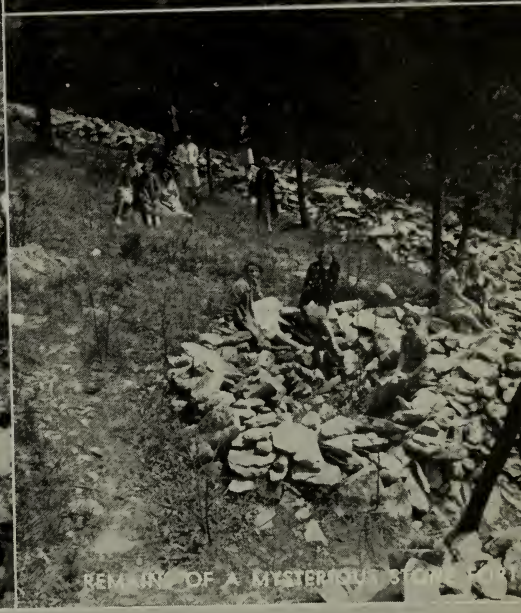
FORT MOUNTAIN STATE PARK

Picture in your mind a steep mountain that rises more than two thousand feet above the floor of the valley, with a summit which is almost inaccessible, but with views of the surrounding country which are unsurpassed in splendor. That is Fort Mountain and Fort Mountain State Park.

Somewhere behind the dawn of history of the North American continent, some one built a fort around the summit of this fascinating peak. This fort, constructed of stone and laid out according to the most approved methods known to military engineering, is over fifteen hundred feet in length, and in places is twelve feet thick at the base. The existence of such a fortification naturally raises the question among both authorities and laymen as to how, why and when this huge, stone wall was constructed. Some ethnologists have

STONE LOOKOUT TOWER

MAGNIFICENT VIEWS OF SURROUNDING COUNT



REMAINS OF A MYSTERIOUS STONE

FORT MOUNTAIN STATE PARK

VIEW OF FORT MOUNTAIN

gone back to the nineteenth annual report of the Bureau of Ethnology, made to the Secretary of the Smithsonian Institution, and found that there was a dim but persistent tradition among the Cherokee Indians that a strange race of white people was here when the Cherokees came. Some of the stories about this unknown race went so far as to locate their former settlements, and to identify them as the constructors of some of the ancient mounds and fortifications in this country. They were known to some of the Indians as moon-eyed people, since they claimed that this prehistoric race could not see in the light of day.

In 1897 Barton's report was inclined to consider them of albino origin. Twenty-six years later, Haywood says that their fortifications in this territory extended down the river as far south as Chickamauga Creek, and that here these moon-eyed people entered into a treaty with the Indian invaders to the effect that they would depart from these lands if allowed to go in peace. Today, both the conquered and conquerors are gone, and this fort, on whose designs no modern engineer could improve, stands as a silent memorial to the invasion of the Cherokees of the South.

Many interesting stories are told about this old fort, which now lies within the boundaries of Fort Mountain State Park. Perhaps the most common is that De Soto, during his march through this region in 1540, was surrounded by hostile Indians and retreated to the summit of the mountain, where he constructed the stone walls as a means of protection. Another story, which has received some attention, designated the fort as work of British agents who were located at Spring Place during the Revolution. Still another tradition is that a band of desperadoes who infested this country in the early days used this walled enclosure as their base of operations. None of these stories have existing evidence, either written or otherwise, to substantiate them. Yet the fortress remains as it has for countless decades, perhaps centuries, an intriguing mystery.

Today the fort is not more than three feet high in many places, but it is evident that the original fortification was much higher. At regular intervals in the wall are pits, twenty-nine in all. The purpose of these pits is not quite clear, but it is believed that they were used either as battle pits or places in which to build fires, so that enemies crossing the wall at night could be plainly seen and shot down. The gateway, which was closed by large stones, led to a spring which lies almost thirteen hundred feet south of the fort.

The park itself, which contains approximately two thousand acres of land between Fort and Cohutta Mountains, is under development

ENTRANCE TO PARK

ALMS WITH BEAUTIFUL SETTING

POOL AND SPANISH INN

SANTO DOMINGO STATE PARK

by the National Park Service. The summit of the mountain is accessible over a state highway and graded park road. A stone lookout tower has been constructed on the crest of Fort Mountain, and plans are under way for the construction of a lake, inn, cabins and all conveniences for those who wish to visit this prehistoric spot and speculate on the mysterious stone fort which has come down to us from somewhere in the dim ages.

SANTO DOMINGO STATE PARK

In the South, there have been several eras on which there is no history, because no records were kept. For instance, in the river bottoms along some of our streams we have great earthen mounds. We know that some of these mounds are ancient because in many instances we have found old forest trees growing upon them. Numerous theories about the earthen mounds have been advanced. Some say they were built by a lost tribe of Aztecs who wandered into this region, or by some other adventurous tribe of Indians who came over from Mexico. Some say that they were made by a race of giant men who inhabited North America even before the Indians.

Our written history starts with the exploration of the Spaniards. After the first Spaniards came—DeSoto looking for gold and Ponce de Leon for the fountain of youth—a different type of men and women from Spain followed. They were the home builders who throughout the history of the world have invariably followed the explorers in the acquisition of new territory. With these new settlers came representatives of the government and of the church, soldiers who built fortifications for a defense in this new world and for protection of their towns and villages against the Indians, priests and other representatives of the church who built missions and places of worship. Most of these first villages and settlements were made either on the islands along the coast or on the banks of one of the larger rivers flowing into the sea. This, of course, assured contact between the inhabitants of this new land and their home country, since most of the travel in those days was done by boat and most of the thoroughfares were along the waterways.

Probably the most important missions of the Georgia coast are Santo Domingo de Talaxe, Nuestra Senora de Guadelupe de Tolomato, and Santa Maria. However, only a few facts about these missions have come down to us—their names, the days of occupancy and some few details covering the activities there. The exact locations of the missions have long been a point for much speculation. Probably the foremost reason is the change in names. There are

only a few places along the southeastern coast today which still retain their Spanish names. The Spaniards had their own names for the islands and rivers of the Georgia coast. When the English came many of those names were changed and the Spanish words forgotten in the long years which followed. We have documentary evidence that those missions did exist, although in certain instances we are not quite sure of their exact locations.

Santo Domingo State Park, three hundred and fifty acres in extent, surrounds a spot said by some to be the site of the Santo Domingo mission. This area has been set aside and dedicated to the period of Spanish occupancy on the Georgia coast. For this reason it is one of Georgia's most interesting state parks. It lies on the banks of the Altamaha River in Glynn County, one-half mile west of United States Highway No. 17, on the site of the old Elizafield plantation.

Books and documents have appeared in increasing numbers within the last few years, all seeking to prove that the tabby ruins are those of the Santo Domingo Spanish mission. The ruins are constructed of tabby, which was the same type and kind of material used by the Spaniards in the construction of their first buildings on the Georgia coast. Some historians, however, are inclined to think that they are merely the remains of a sugar mill built in the early days of colonial occupancy. Whatever they are, the tabby ruins commemorate some ancient era of Georgia history.

They are located on the banks of a deep lagoon which is said to have been the mouth of one of the numerous creeks flowing into the Altamaha. Surrounding the ruins is a grove of beautiful trees—live oak, laurel oak, hickory, pine—all hung with tapestries of Spanish moss. Walking along the trails which twist and turn with the shore line of the lagoon under the magnificent forest one cannot help but feel a sense of nearness to his Creator. There is a quiet restfulness which imparts a sense of suspended life among the creatures of the forest. In places picturesque bridges have been built over the lagoon. One gets the impression that these trails are as they might have been in the first days when the Spanish came, and when the Indian village was located on the bluff overlooking the lagoon.

In the glass exhibit cases of the museum there are a number of tools and implements said to be of Spanish origin. There are bronze and iron axes which were dug out of the mud of the lagoon. Lying side by side with these are a number of Indian implements, such as axes, arrow heads, and even part of an old dugout canoe identified by the Smithsonian Institution as of Indian origin.

Many improvements have been made at Santo Domingo State Park. As the site of the old Elizafield plantation, a Spanish inn has been erected. This inn was built of the same type of material and constructed along the same lines of design as were used by the Spanish in the seventeenth century. There are modern improvements, of course, such as water, heat, electric lights, etc. From this inn, trails lead to a picnic area and to other sections of the park.

The history of the old Elizafield plantation is very interesting. The story is typical of that of many other plantations throughout the South. There were slaves and slave quarters, extensive rice and indigo fields, and at one time there was a tabby schoolhouse on the property. One may still see evidences of a lovely old southern formal garden with hollyhock, crepe myrtle and lilac. Santo Domingo State Park lies in the center of the most historic section of Georgia. Nearby is old Fort King George, built in 1721 by the Carolinians and occupied until 1727. On the shores of the Altamaha River above the park is the site of Fort Barrington, built in 1720 and called Fort Howe during the Revolution. On St. Simons Island, near Brunswick, lies Fort Frederica, built in 1736 by Oglethorpe. Near it is the scene of the battle of Bloody Marsh in 1739. Farther up the coast is the dead town of Sunbury, once one of the largest towns in the state, but today it is marked by only a small cemetery and one remaining house on the bank of a deep, salt river winding through the marsh. This section of Georgia was once known as Guale (pronounced "Wally"). This name is supposed to have been applied to an island on the Georgia coast, but it was given by the Indians to the entire section of the Atlantic seaboard. It is interesting, also, to know that all Spanish settlements were abandoned by the year 1702.

We feel that in Santo Domingo State Park has been preserved some of the glory and tradition which was the old South, both in the reputed mission ruins and in the old Elizafield plantation.

ALEXANDER H. STEPHENS MEMORIAL STATE PARK

Deep in the heart of the Piedmont region of the South, on the old Georgia Railroad between Atlanta and Augusta, lies Alexander H. Stephens Memorial State Park. This park, more than any other in the state system, was established as a memorial to one of the southern leaders during the days of conflict when the nation was divided against itself.

In 1933, Liberty Hall, the home (and approximately twenty acres) of Alexander H. Stephens, vice-president of the Confederacy,

PARK BATH HOUSE AND LAKE

INTERIOR VIEW OF STEPHENS HOME

ALEXANDER H. STEPHENS MEMORIAL PARK

STEPHENS MONUMENT AND HOME

OBSERVATION TOWER

was controlled by the Stephens Memorial Association. At the advent of the Civilian Conservation Corps this property, with enough additional acreage to bring the park to approximately two hundred and sixty-three acres, was deeded by the citizens of Crawfordville and Taliaferro County, the United Daughters of the Confederacy, and by the Stephens Memorial Association to the state of Georgia. It became known as the Alexander H. Stephens Memorial State Park. Since then the park has been completely developed.

Liberty Hall was restored, refurnished and brought back to the original Liberty Hall of Stephens' lifetime. Much of the furniture was collected by Mrs. Horace M. Holden, grandniece of Stephens, and by the United Daughters of the Confederacy, and replaced in the home. The few items of furniture which could not be located were replaced with replicas. Even the wall paper and carpets, of which samples had been saved, were reproduced and used in the rooms. The slave quarters, the old gas house, which was one of the earliest artificial light producing plants in Georgia, the wine cellar, and the vegetable and formal gardens have been restored as they were during the life of the Great Commoner. Stephen's library has been almost restored, twelve thousand volumes being donated by Mrs. Holden and Judge Alex W. Stephens, grandnephew of Stephens.

Stephens sleeps in front of the house in the center of a spacious lawn. Beside his grave a monument erected to him bears one of his characteristic poses—that of a great orator. On one side of the monument are engraved words which were typical of the man, "I am afraid of nothing on the earth, or above the earth, or under the earth, except to do wrong. The path of duty I shall ever endeavor to travel—fearing no evil, and dreading no consequences."

One-half mile beyond Liberty Hall, across a small ridge, lies Lake Liberty, a small artificial lake constructed by the Civilian Conservation Corps. A bath house on the shore of the lake is designed along the lines of the colonial homes built during the period of Stephens. Scenic drives and trails lead back into the wilderness area on the northern side of the park. Picnic areas and shelters are available for large and small groups. Trails for nature students lead into remote regions of the park.

Many interesting stories have been built about the life of Alexander H. Stephens. Probably one of the most interesting is in connection with his lifelong friend, the famous Robert Toombs. Although very good friends, these two men were often on opposite sides of political situations. Frequently during a disagreement, they held heated public debates. It was during one of these debates in

the presence of a large audience that Toombs turned to his friend and said, "You little runt, I could swallow you in one gulp." Stephens retorted instantly, "Yes, you could, and then you would have more brains in your belly than you have got in your head."

Physically, Stephens was a small but energetic man, although the last years of his life were spent in a wheel chair. Never during his lifetime did he weigh over one hundred pounds, but what he lacked in stature, he made up in indomitable courage. It is said that during his lifetime he challenged three men to duels, and one heated argument almost cost him his life when his opponent stabbed him time and time again with a knife, trying to make him yield. His convictions were based on the highest ideals.

Alexander H. Stephens was fond of all living creatures. He was exceedingly fond of his fellow men. He kept a guest room with an outside entrance, so that anyone passing by might stop in and spend the night. They were welcomed to his table if they arrived in time for supper, and they were expected to have breakfast before leaving the next morning. It is said that many persons whom he never saw spent the night in his home. Some were travelers of wealth, and some were tramps, yet they all recognized in the great statesman a friend who would share with them all of his worldly possessions.

Stephens loved dogs and horses. During his lifetime, he had many dogs. One he taught to get the mail and bring packages across the railroad from Crawfordville. When each dog died he was buried in a certain spot in the garden under a stone. The stone pile is still there. Linton Stephens, brother of the Great Commoner, once wrote an epitaph for that pile of stone—

"Here rest the remains
Of what in life was a satire on the human race
And an honor to his own—
A faithful dog."

Today, many thousands of visitors come from all over the United States to see Liberty Hall, the garden which has been replanted in old fashioned flowers and vegetables, the well house and the recreational area. Liberty Hall and its grounds are generally recognized as one of the best preserved examples of its kind in the South.

CHEHAW STATE PARK

In Dougherty County, on the outskirts of the pleasant and attractive city of Albany, lies Chehaw State Park. Chehaw was named after a picturesque tribe of Creeks, whose domain once included most of the Piedmont Plateau and coastal plain of the southern states.

Little exact data are available as to the size of this tribe of Chehaws for whom the park is named. A census taken in 1832 shows that it was composed of one hundred and six members. Today, walking over the open places adjacent to the lake and over the hills of the area, one can visualize the existence of a once vast tribe. Evidences in the form of many kinds of artifacts remain as a mute expression of the culture of a vanished race.

In spite of the fact that this area has long been a source of supply for the collectors, many artifacts may still be found. Here and there an arrowhead, a piece of pottery, or some form of stone implement is a relic of the tribe that lived in this vicinity more than one hundred years ago. Arrowheads, spearheads, tomahawks, hoes, drills and scrapers, clay pipes and stone celts have been found along the banks of one creek and in the neighboring fields. Pottery making was an important activity. A great variety of workmanship has been found which might lead to the belief that several occupations were carried on in the area. Some of the chipped artifacts display excellent workmanship, bearing interesting decorations. Many of them are highly artistic; others are crudely fashioned by their makers and display only the simplest development.

Dr. John R. Swanton, eminent scientist who has devoted considerable time to the study of Indian villages, sites and trails in the vicinity of Chehaw State Park says, "Of course, I have treated the tribe or tribes called 'Chehaw' in Bulletin 73. The first mention of the name is in the DeSoto Chronicles, from which it appears that there was a town of this name on the Tennessee River and probably on Burns Island. They still were there when Pardo passed along the river in 1567, and their name once was given to Tallapoosa River; and there is a creek still called by a form of this name in northern Alabama, or at least so called not so very long ago.

"The people of the Tennessee may have moved into the Upper Creek country. Another section of the tribe, a second tribe so called, lived with or near the Yamasee, and there is a stream in the southern part of South Carolina which bears the name. Later, they moved to the Ocmulgee and then to the Chattahoochee. The Chiaha, or Chehaw, Indians who lived on the site of the present park, separated from those on the Chattahoochee because they were friendly to the whites while the others were hostile. Later, they seem to have gone south into Florida, and probably they were the ancestors of the Mikasauki Indians, at least in part."

This substantiates in part the belief of some who think that the Chehaw tribe of Indians was originally a separate group, not con-

BORDER OF PARK LAKE

PARK LAKE VISTA

LONGLEAF PINE NEEDLES AND "CANDLES"
BEAUTIFULLY DISPLAYED

CHEHAW STATE PARK

PARK PICNIC SHELTER

nected in any way with the confederation of the Creek nation. The Bureau of Ethnology points out that the Indian name was "Chiha," and that it closely resembles the word "Chaha," which when translated means "high." That seems to be significant of the fact that earliest record of the Chehaw tribe places it in a country near the mountains of Tennessee.

Possibly three hundred years ago the Chehaws came to lower Georgia to take their place in the Creek nation and were there when the first white men found them. In 1799, Hawkins, one of our historians, tells us of the activities of the Chehaw tribe—"These people have villages on the waters of the Flint River where they have fine stocks of cattle, cows, horses, and they raise corn, rice and potatoes in great plenty. The following are the villages of this town: Aumuc-cul-lee (which means "pour on me") is a creek of that name which joins with the right side of Flint River, forty-five miles below Timothy Barnard's. It is sixty feet wide, and the main branch of Kitch-o-foo-ne creek. The land is poor and flat, with limestone springs in the neighborhood."

These two creeks which the historian of one hundred and thirty-seven years ago mentioned in his narrative are easily identified as Muckalee and Kinchafoonee which run by the park today.

Chehaw State Park is developed around this rich historical background. Roads and winding trails have been built under the pine and hardwood forests and along the shore of the lake. From the bluffs to the shore line is an almost jungle growth of large trees with festoons of hanging moss. A picnic shelter, outdoor fireplaces, tables and benches have been constructed at suitable sites in the park area. A beautiful lagoon lies between the picnic shelter and the lake. This lagoon is full of a variety of fish. Certain portions of the area which were farmed heavily for a great many years have been replanted in trees, and will eventually be restored to an unbroken stand of timber. The park itself will provide opportunities for hiking, boating, swimming, picnicking and nature study, with the historical background of an almost lost tribe of Indians.

LITTLE OCMULGEE STATE PARK

Little Ocmulgee State Park lies near McRae, Georgia, and is one of the scenic areas in that section of the state, with high sand hills, longleaf pine, scrub oak, and deep, dense swamps filled with a variety of trees and other plants. Here again we revert to the history of the Creek Indians for our background. According to Dr. Swanton, the origin of the English term "Creeks" seems to have been traced to a

ADQUARTERS

ROAD WINDING THROUGH PARK AREA

PICNIC SHELTER

RUSTIC SEAT DECORATED WITH ANIMATE BEA

LITTLE OCMULGEE STATE PARK

shortening of "O chee se Creek Indians." Ocheese was the old name for the Ocmulgee River upon which most of the Creeks were living when the English first came in contact with them. Ocmulgee means the "bubbling up of water in a spring," and probably refers to the same spring from which the Ocmulgee River got its name, Indian Springs in Indian Springs State Park. Little Ocmulgee was known to the Indians as "Au chee ha chee."

Plans are under way for the construction of a two hundred and fifty acre lake which will lie between the high sand hills, and which will provide swimming, boating and fishing facilities. A beautiful lodge has been completed. Behind the lodge, near a large parking area, is a picnic shelter. Barbecue pits, outdoor fireplaces, and ample benches and tables to accommodate large groups of picnickers have been provided. Trails leading into all sections of the area offer unusual opportunities for study of our middle Georgia wild life. The area abounds in squirrels and birds. Quail, deer and turkey come out of the Ocmulgee swamps and are seen in the park. The park itself is truly recreational and will be open to the public within the next few seasons.

INDIAN SPRINGS STATE PARK

Douglas Watson halted abruptly and stepped out of the game trail he was following. He disappeared so quickly and completely that a squirrel, which had scampered up the opposite surface of the trail-side oak and appeared again at the first branch to scold, stared for a long minute at the spot where he had last seen the white man.

Watson stood like one of the noon-day shadows and watched and listened. Beyond the thicket of canes, he could hear the low murmur of the creek. A few mid-summer birds sang desultory songs in the ancient grove of oaks and hickories on the hill. The summer noon was peaceful and warm and comfortable, as it should have been. No tension, no suspense was in the air.

Douglas Watson was quick to comprehend danger. Many times he had been saved by a broken twig—a footprint in the sand. He avoided that part of the forest where the birds did not sing—that swamp where the tree toads were still. He was a government scout, assigned to this new southern frontier, where the Creek Indian tribe had rebelled against the encroachment on their lands by the white man.

Today, though his ears and eyes told him that all was well along the creek, the scout had been warned by his nose. He had smelled gunpowder smoke!


PAVILION IN PARK
THE FAMOUS SPRING
INDIAN MUSEUM
INDIAN SPRINGS STATE PARK

He stood motionless for many minutes, his eyes probing the lights and shadows of the forest. He was in the middle of the hostile Creek nation. Eagerness for the warpath, which had reached a peak during the recent Revolutionary War, was felt throughout the tribe. Thirty miles or more to the south was Fort Hawkins on the Ocmulgee River. A skirmish here could not hope to benefit the cause of his own state or government.

Watson did not return to the game trail. He turned north and west up the hill and made a wide, silent detour around the spot where he had smelled gunpowder.

Later he learned that the smell of gunpowder smoke was really the odor of a cold mineral spring bubbling out of the hillside, and that this spring was held sacred by the Creek people because of its healing qualities. His story is our first record of Indian Springs.

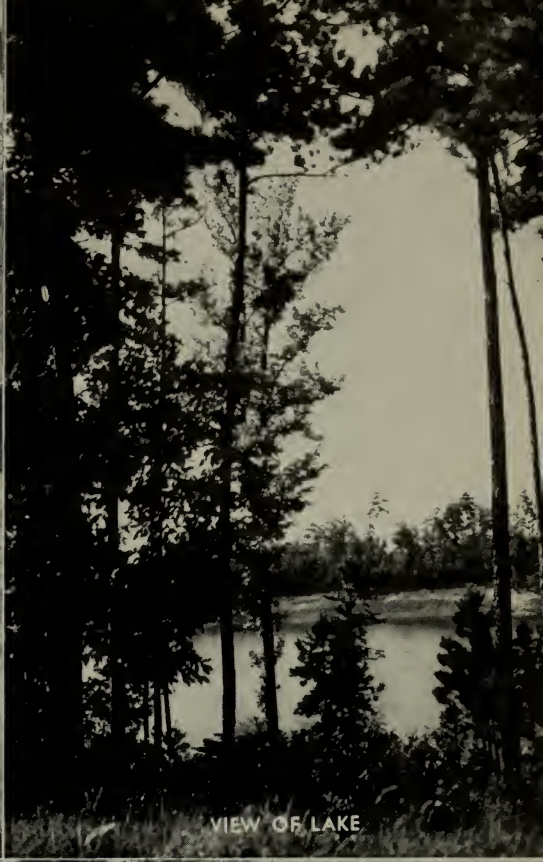
Today that famous spring lies in the heart of Indian Springs State Park. The spring and the ten acres immediately surrounding it have never been in private ownership, but have been reserved by the state of Georgia as a health resort for its people since 1825 when the Creek Indians gave it by treaty to the state. This treaty, known as the Treaty of Indian Springs, was signed near this spot and is remembered as one of the most famous treaties in Indian history. It caused the death of its principal signer, the famous half-breed Creek chief, General William McIntosh, and a disagreement over its validity nearly caused Georgia to have her own private war with the United States government. In the treaty the Creeks ceded the last of their Georgia land.

The old home of General McIntosh still stands. Built about 1820, it is one of the most interesting historic structures remaining to tell the story of the departure of the red man from Georgia. It stands across the highway from the park and is in private ownership; it is visited by many tourists.

Public facilities have been provided for those who visit Indian Springs State Park. Facing the spring house is a large stone pavilion where one may purchase refreshments, or may play, or merely sit quietly and rest. Two large picnic groves, with tables, benches and outdoor fireplaces, contain ample facilities to provide for approximately six hundred persons. Comfort stations are provided near the center of the park. Two large parking areas have been constructed. One may be reached through the north park entrance. The other is located near the museum which is maintained and operated by the Butts County Historical Society. A swimming pool and hotel accommodations adjoin the park.

PARK TAVERN

INTERIOR VIEW OF TAVERN



VIEW OF LAKE

FEEDING WILD GEESE ON LAKE

ONE OF THE LOG CABINS

PINE MOUNTAIN STATE PARK

STONE BRIDGE IN PARK

Indian Springs is located between Forsyth and Jackson, on the popular paved route between Atlanta and Macon.

The beautiful and historic park is visited by many thousands each year. The virgin hillside is much the same as it was on the day Douglas Watson discovered it. The game trail has been made into a footpath and other picturesque trails have been cut through the forest. A sand beach and children's playground are provided near the creek. Innumerable birds and other animals make nature study a delightful pastime.

PINE MOUNTAIN STATE PARK

In the heart of Georgia, far down in the Piedmont Plateau, lies Georgia's southernmost mountain. It is a high wooded ridge, almost fifty miles in length, and in spots it reaches skyward to more than 1350 feet above sea level. The name of this beautiful Georgia ridge is Pine Mountain.

There, one hundred years ago, a stage coach road traversed the mountain at King's Gap, which was one of the famous Indian trail passes of the state. This road was used by early travelers between Hamilton on the south and Bullsboro on the north. At one time the town of King's Gap was a thriving, though short-lived community. A United States post office was located there, and today letters are in existence which bear the postmark of King's Gap. This post office was supposed to have been erected some time during the year 1837, and was a stop-over for the stage coach line which ran from Columbus to Greenville and Newnan.

In the northeast corner of the park, at the foot of the mountain, is the site of an old settlement, which contained a church, a cotton gin, a tanyard, and a gristmill. Power was supplied by a spring which ran from under one of the mountains. When the railroad was built across Pine Mountain, the old town gradually moved nearer the tracks, and the new town was given the name of Hood. Hood was finally abandoned for the more favorable site on which the town of Chipley now stands. The remains of the mill race at the original site of the town of King's Gap, the tanyard vats, and a few ancient gnarled fruit trees are all that is left of the old settlement which flourished in the days of the stage coach.

Geographically, Pine Mountain is as interesting as any spot on the Piedmont Plateau of Georgia. This unusual location affords a commanding view of all the surrounding territory. Pine Mountain may be seen by those approaching it from the north as far away as Greenville, and from the south as far as Columbus. South of Wood-

bury, Pine Mountain and Oak Mountain meet in a complete loop known as the "Cove." Below the Cove, the Flint River has cut a narrow gorge through the range. This gorge is six miles in length and three hundred to four hundred feet deep.

There have been several geological periods in the formation of the rocks at Pine Mountain. The first rocks are said to have been deposited as sediment many millions of years ago in the late Pre-Cambrian period. This period is estimated by geologists to be between 250 and 500 million years ago. At that time an ocean covered the area and the sediments, which were layers of clay and sand, were deposited much in the same manner as they are deposited along the Atlantic coast today. Millions of years passed and this primeval ocean receded. Earthquakes occurred, buckling the clay and sand into sharp folds. During these earthquakes molten granite from within the earth was thrown up into the folded sediments. Severe heat cooked this granite under high pressure, making mica flakes and changing the sand stone into massive beds of quartzite. Within the next few million years the rocks were again subjected to the moving forces of the earth. This was the period of the great mountain making movement, extending from Alabama to Nova Scotia. During this time the Appalachain Mountains were raised to their greatest prominence. In Pine Mountain the rocks were broken into blocks and each block was shoved over its northern neighbor, sometimes moving heavy masses many thousands of feet. A few million more years passed and great sheets of lava boiled out of the earth and poured out of Pine Mountain. At that time the Palisades of the Hudson River were formed. Although no ancient volcanos producing lava are known in Georgia, it is supposed by geologists that they must have once existed. It is interesting to know that this was the period of the dinosaurs, although no dinosaur remains have been found in this state.

Thus was Pine Mountain made. During the millions of years which have elapsed since the last great change in its formation, it has weathered and worn away. Miraculous and numerous changes have been wrought by nature. Today, the barren slopes are clothed with trees and flowers and grass. Clear streams trickle out from under the rocks, and we have Pine Mountain as it is today.

A few years ago, at the beginning of the Civilian Conservation Corps era, a few public spirited citizens acquired and donated over 1500 acres on the crest and both sides of Pine Mountain to the state of Georgia. Two CCC Camps were set up in the vicinity, and work on this middle Georgia playground began.

Pine Mountain State Park was opened to the public in the spring of 1938. A great many facilities and conveniences have been provided for the enjoyment of all those who come to visit it. There are picturesque, winding trails down the slopes and along the streams. There are magnificent ravines choked with laurel and with wild mountain flowers. The crest of the mountain itself, which offers a panorama of magnificent views, is accessible by the new Pine Mountain Parkway, a beautiful road along the mountain top from Tip Top Gap to Warm Springs. On the crest of the ridge is located a large stone inn and four stone cabins. Around the fifteen acre lake on the northern slope of the mountain, seven log cabins, a bathing beach, a picnic shelter and adequate picnicking conveniences are available for those who wish to spend one day, one week, or longer in the state park. On the old trails, amid the grandeur of the scenery, one is sometimes reminded of history that is still in the making. The visitor can usually catch the spirit of ancient King's Gap, of the old Indian burial grounds near the Chattahoochee River, of General McIntosh who was responsible for the ceding of this land from the Creek Indians to the state of Georgia. But the era of conflict is dead. Tustenuggee, Yoholo, and Paddy Carr have moved on and the peaceful state park, lying under the crest of one of the most ancient and divinely created formations remains as a convenience and beauty spot for those who wish to go and commune with the past.

Warm Springs, lying in the town which bears its name, and several miles from the state park, is said to be approximately twenty-five degrees warmer than the other springs in the same area. Geologists have estimated that with a temperature of eighty-seven degrees the water is drawn from a depth of more than six hundred feet below the surface of the earth. Warm Springs is famous for its health-giving qualities. As early as 1825 a tavern was built near this spring. Many guests from all over the South came each year to receive the benefit of the mineral water.

Adjacent to Pine Mountain State Park is the National Park Service Recreational Demonstration Project which includes 3500 acres of mountain slopes. This project will be used by organized camps for boys and girls from towns in that section of the state who would not otherwise be able to have an outdoor vacation.

Pine Mountain Valley Rural Community adjoins the park and can be seen from the mountain crest. It is a model farm area on which hundreds of families have been located and made happy and self-supporting.

JEFFERSON DAVIS MEMORIAL STATE PARK

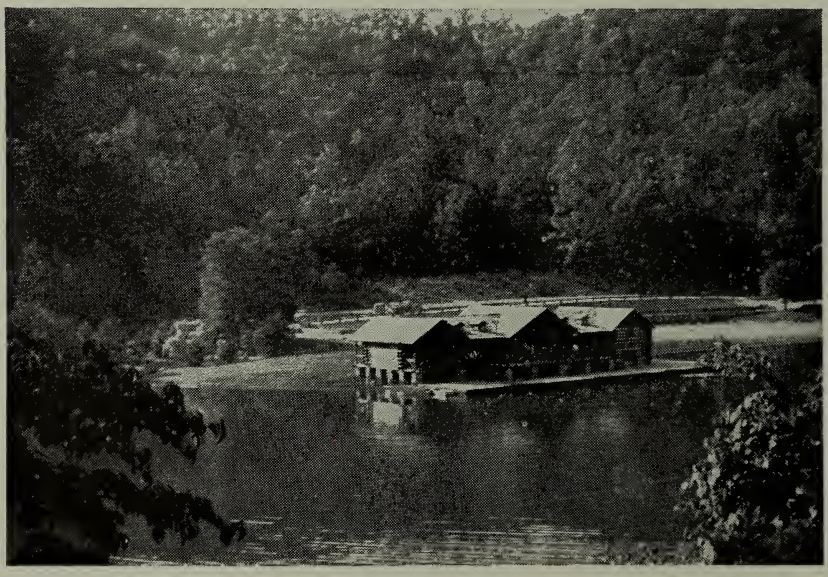
This park, lying near Irwinville, Georgia, is the smallest at present in the Georgia park system. It surrounds and is a memorial to the site where President Jefferson Davis of the Confederate States of America performed the last official duties of his office. Upon this site Davis was captured by Federal troops.

A huge stone marker designates the exact spot of his capture on May 10, 1865, and nearby, another spot where a United States trooper was killed, is also marked. It is said that President Davis was en route from Richmond to the West, where he hoped to rally the army of the trans-Mississippi and save the cause of the Confederacy.

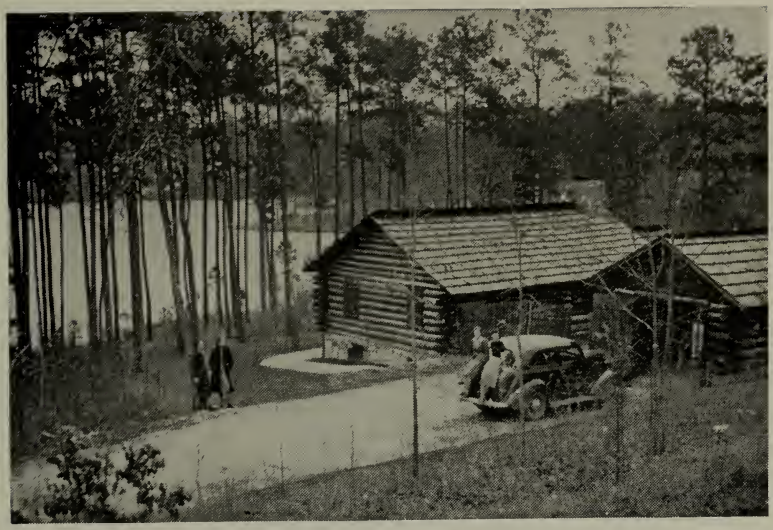
The purpose of the park is to commemorate the ideals of the Confederate States, as exemplified in the person of its Chief Executive, and to perpetuate in the hearts of the people the principles of constitutional government which the Confederate fathers sought to perpetuate. Funds have been provided for the construction of a small museum near the beautiful and ancient longleaf pines of the park. In this museum relics of another period of Georgia's history will be displayed.

Resting Place on a Mountain Trail with Sweeping Mountain Scene in View.

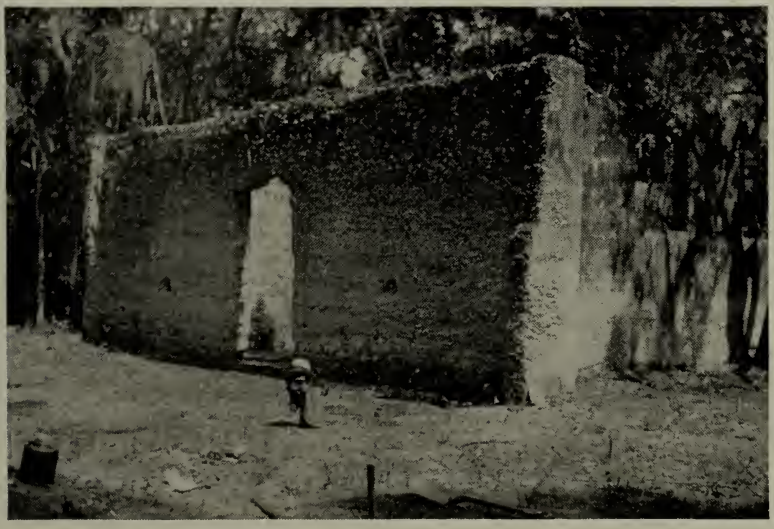
In the building on the right is the famous mineral spring of the Indian Springs Park.



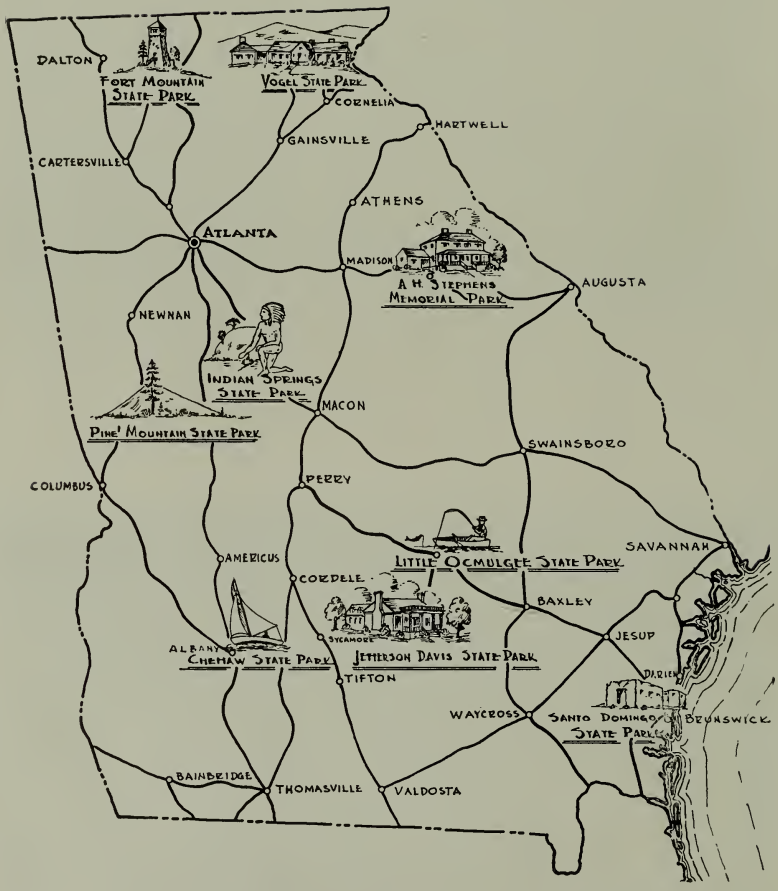
View of the Bathing and Boating House at Lake—Vogel State Park.



One of the log cabins at Pine Mountain State Park with lake in background.



Part of the old ruins believed to be of Spanish mission constructed in the seventeenth century, at Santo Domingo State Park.



Map Showing Locations of State Parks of Georgia.

WILD LIFE RESOURCES OF GEORGIA

Their Protection and Development

Prepared by

The Division of Wild Life

OF THE

Department of Natural Resources

Wild Life Resources of Georgia

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SPECIAL TABLE OF CONTENTS

Wild Life Resources of Georgia

CHAPTER I

IMPORTANCE OF WILD LIFE IN GEORGIA

The term "wild life" used in this discussion means birds and animals in their wild or natural state living in forests, fields and marshes; and useful life of streams, lakes and coastal waters, including fish, oysters and shrimp.

The economic importance of wild life to Georgia can not be expressed in dollars and cents nor fully appraised in any terms. Aside from the value of its coastal fisheries and related industries, yielding an income of about $1,000,000 annually, there are vast contributions of fish, wild animals and birds to the food of individual families for which there are no figures. Greater even than the food value of wild life, are the benefits contributed by birds in protecting field crops and forests from insect damage. Then, too, there are great human values derived from outdoor recreation of hunting and fishing.

ADVANTAGES. Georgia is unexcelled for desirable habitats of birds, animals and aquatic life. Wild life that requires forest environment finds 23,000,000 acres, or nearly two-thirds of the state's land area, available.

The coastal waters of Georgia, extending directly about one hundred miles, have a shore line of sounds, estuaries and tidal rivers of about 1,000 miles where sea life has favorable conditions in which to thrive.

For birds that do best in open areas, like the quail and dove, there are enough open fields for their needs, and usually enough coverage to protect them from their enemies.

Birds and wild animals have a great variety of natural foods provided by the fruit of many species of trees and shrubs, by berries and seeds of numerous kinds of wild plants, by residues of field crops and by abundant insects. Wild grasses and other herbage provide abundant grazing for deer the greater part of the year.

HINDRANCES. Before Georgia was settled by the whites its area was covered with forest growth. Streams ran clear; their waters were deep and occupied by a great variety of fish. But the white man came and cleared off some of the forests to provide farm land and

burned over the remainder. Game and fish were then beset with adversities greater than they had ever confronted, and their numbers dwindled. Fish like the trout and bass which thrive only in the environment of clear water, found the streams constantly muddy with silt eroded from farm lands, and disappeared.

Man with his fire destroyed food and coverage of birds and wild animals. All the while the crack of the rifle and shot gun have rung through forest and field, taking heavy toll, until Georgia—a natural paradise for wild life—became a place of precarious existence for wild animals; so much so that the beaver became almost extinct and other animals and birds much sought after by man maintain sparse existence only in remote places.

Unlike man who seems never to know where to stop in taking toll of wild life, Mother Nature has a way of progress and checks that maintain a biotic balance, or equilibrium of living things. For instance, when insects are overabundant and injurious to plant life, birds are attracted by the abundant food provided and subdue these plant enemies. If grubs are too numerous for the welfare of vegetation, rodents appear in numbers to devour them, and if rodents become a menace, the owl by night and the hawk by day pounce upon them. Where trees have too thick a stand, Mother Nature attends to the thinning. Thus, and in many other ways, nature maintains her equilibrium of living things.

But man has handicapped nature so that it can not provide the checks and counter-checks, nor in some particulars create environmental conditions favorable to building up a form of life that has been depressed by adversities. Since man is responsible for suppressing nature, only by the aid of man can normal conditions be restored.

CHAPTER II

WHAT GEORGIA IS UNDERTAKING TO DO

Georgia came to realize that wild life would have to be protected and regulations would have to be enforced to restrain man's rapacious attitude toward game and fish. As a consequence the state legislature enacted a law in 1911 creating the Department of Game and Fish. In 1937 the name of the department was changed and is now the Division of Wild Life of the Department of Natural Resources.

To have officers at all places where fishing and hunting are in progress in the 159 counties of the state is of course impossible. Therefore, it is the policy of the Division of Wild Life to secure

the co-operation of citizens interested in maintaining or increasing the wild life of their communities, hence the formation of Fish and Game Clubs, of which there are 211 in the state in 1938.

Above—View of the nesting places for quail made at the State Game Farm near Atlanta. Below—Eggs of the native bobwhite gathered from their nests at the hatchery.

Through these clubs an effort is being made to educate the general public as to the provisions of the law and to create a supporting public sentiment. By such methods great assistance is rendered the state's game and fish protectors in obtaining compliance with the law.

Georgia has ninety game protectors whose duties are to see that the required licenses for fishing and hunting are obtained, and that the provisions of the law as to the "take" of game and fish are not violated.

GAME AND FISH PROPAGATION. The state Division of Wild Life does not confine its activities to law enforcement. It is engaged in replenishing the state's supply of wild life. At Doraville, near Atlanta, the Division has a state game farm, one of the best equipped in the country. Here thousands of bobwhites are hatched and distributed annually over the state. Experiments are also being conducted in growing chuckor or Asiatic partridges, which if successful, will result in releasing thousands of these birds in the state. A chapter in the bulletin is devoted to a discussion of the bobwhites.

Georgia has six fish hatcheries which are annually producing millions of game fish for stocking streams all over the state. Trout, bass, bream and shad are the chief game fish produced.

The names of the hatcheries and their location are as follows:

Summerville Hatchery, Summerville.
Magnolia Springs Hatchery, Millen.
Bowen's Mill Hatchery, Fitzgerald.
Tuft Springs Hatchery, Macon.
Ways Station Hatchery, Ways Station.
King's Ferry Hatchery, King's Ferry.

How a hatchery is operated is described in another chapter.

EDUCATION. The Division of Wild Life is conducting an educational campaign to develop public sentiment favorable not only for law observance, but for creating public interest and co-operation in measures for increasing Georgia's wild life. To this end, exhibits, lectures, moving pictures and literature are employed, and many letters of inquiry are answered daily.

In an effort to meet a demand for teaching material, a treatise on the bobwhites was provided for 300 schools in 1937, and the publication herewith presented is designed to reach all of the high schools of the state.

Experience reveals that the subject of wild life is popular with all classes of people; and exhibits, lectures and moving pictures do

not fail to draw large crowds, evidencing the fact that Georgia's citizens are interested and need only direction to make better conditions for wild life.

Thousands of quail are distributed over the state each year from the state's modern hatchery. Left—Some of the contented, hatchery bred bobwhites at the Game Farm. Right—Some of the large Asiatic or chuckor quail grown experimentally at the Game Farm.

CHAPTER III

COASTAL FISHERIES

Along the 1,000 mile shore line of Georgia estuaries, sounds and tidal rivers, thousands of Georgians and people from other parts of the country delight to fish. This interesting sport and outdoor recreation make the coast a place for healthful and delightful vacations.

But while Georgia's coast provides sport and recreation, many people of that region depend upon fishing for a livelihood. The United States Bureau of Fisheries reported in 1934 (the latest available figures) a catch of 27,140,900 pounds of fish, valued at $359,510. The record of 54 years shows that the fishing industry on the Georgia coast gained its greatest proportions in 1927, when the catch was 47,607,220 pounds and valued at $697,165; but the largest revenue obtained was in 1929 when the 43,513,641 pounds brought $877,232. In 1931, when the depression came, the catch was down to 7,349,813 pounds, but it is rising. In 1932 the catch was 16,522,995 pounds and in 1934, as mentioned, it had reached 27,140,900 pounds.

By far the greatest catch in 1934 was menhaden, a small fish caught by great nets launched from vessels where shoals of the shining fish are moving through the sea. Menhaden are used for oil and the

residue as fertilizers. In 1934 the catch of menhaden was 18,751,500 pounds, valued at $63,859.

Second in quantity was shrimp, 6,842,900 pounds, valued at $203,127.

The following table gives the species of fish and shellfish, the pounds and value of each in 1934:

FISHERIES OF GEORGIA

TOTAL CATCH AND VALUE OF SPECIES
1934

Species of Fish	*Pounds*	*Value*
Catfish and bullheads	52,500	$ 3,150
Croaker	7,000	280
Drum, red or redfish	2,500	125
Flounders	3,300	96
Hickory shad	10,500	1,042
King whiting or "kingfish"	12,000	380
Menhaden	18,751,500	63,859
Mullet	59,000	2,600
Sea bass	23,000	690
Shad	232,000	38,400
Spot	13,000	460
Squeteagues or "sea trout", spotted	56,000	4,480
Sturgeon	11,600	928
Total	19,233,900	$116,490
Species of Shellfish, etc.		
Crabs:		
Hard	483,500	7,252
Shrimp	6,842,900	203,127
Oysters:		
Market, private, spring	327,600	16,588
Market, private, fall	241,100	14,773
Terrapin, diamond back	11,900	1,280
Total	7,907,000	243,020
Grand Total	27,140,900	$359,510

It is well to know something of the most important food fish taken in saline waters.

SHRIMP. Shrimp spawn in deep sea water in April, May, June, July, and to a less extent in August and September. When hatched the young shrimp is only about one-seventh of an inch long. Carried by currents it reaches inside shallower waters where it grows rapidly and eventually moves out into deeper waters.

The life of a shrimp is thought to be barely a year in length. The greatest number are caught in the fall by trawling or seining along the banks. Overfishing, or taking of shrimp that are too small, may deplete the supply. To forestall depletion the amount of the catch and size of the shrimp have to be noted and regulations instituted to increase the supply.

Deep Sea Fish Caught off the Coast of Georgia—A Catch of Mostly Sea Bass.

OYSTERS. The production of oysters in Georgia coastal waters is far from what it has been and can be. The decline, as stated by the U. S. Bureau of Fisheries, is due to overfishing and lack of adequate oyster cultivation. During a period of 54 years, the peak of oyster catch was 1,436,000 bushels in 1908. In 1934 the catch had fallen to 96,717 bushels.

The oyster is primarily a shore or shallow water creature. Spawning occurs when water reaches a temperature of 68 or 70 degrees. As soon as hatched the small oyster larva swims by means of fine hairs attached to its body. When only about one seventy-fifth of an inch long it ceases swimming about and attaches itself to a rock, shell, stake or other object.

Oysters grow more rapidly in warm than in cold water. In about two years the oyster reaches a length of four or five inches and is then of commercial size. Left undisturbed they may grow eight to ten inches long. Evidence indicates they may live as long as fifteen years.

Restoration of oyster production in Georgia's coastal water involves replacing each year 25 per cent of the number of bushels of oysters taken from an area. If these young oysters are "planted" at the right time and place, great benefit will result in maintaining the natural beds.

Oysters can be planted in beds where all live oysters have been taken out, and if the bed is protected until established, production will be renewed.

Oyster culture consists in setting aside areas; improving their beds by dredging out debris and grass and applying shells and gravel; establishing spawning grounds; collecting seed oysters and transplanting on suitable bottoms below the low-water mark, and protecting the beds from drills and other enemies .

The Bureau of Fisheries estimates that not more than one-tenth of Georgia's area suitable for oyster cultivation is being used. The area is capable of producing 8,500,000 bushels annually, valued at $1,250,000 to the producers.

Except for limited areas, clearly defined, oysters on the coast of Georgia grow in uncontaminated waters, and none in contaminated waters are permitted to enter the market.

SHAD. Second in commercial importance in the revenue derived from Georgia's fisheries is the shad, which brings an average of twenty cents a pound compared to about five cents for other edible fish. The 232,000 pounds caught in 1934 were valued at $38,400. The catch of this valuable fish has also declined not only in Georgia but elsewhere.

The shad's flesh is rich but not oily, and its eggs, or roe, are considered a great delicacy. Its habit of migrating up streams to spawn has provided stream fishermen their most exciting sport.

The shad spawns in stream headwaters. The hatching period is from six to ten days. The newly hatched shad is less than four-tenths of an inch long and has a large yolk sac to provide food for about a week. By fall the shad are three to seven inches long and by November or December they have moved to the sea.

Many streams of Georgia once had abundant shad in season but because of stream pollution with silt or clay, refuse and waste, and obstruction with dams, shad ceased appearing or are rarely seen.

The Bureau of Fisheries accounts for the depleting of shad by the action of three factors, overfishing, obstruction of the spawning grounds and pollution of the streams.

To save the shad in Georgia, propagation and restocking and drastic regulations are apparently necessary. A shad hatchery has been established by the state Division of Wild Life near the coast at King's Ferry.

A String of Winter Trout Caught off the Coast of Georgia.

CHAPTER IV

FISH HATCHERIES

The purpose of a fish hatchery is to provide ideal conditions for incubating the roe or eggs of fish and for rearing the young until they are of a size to release into rearing pools, or streams.

The first consideration in selecting a site for a fish hatchery is abundance of suitable water that can be brought completely under control. Well protected springs and spring-fed brooks usually provide the best water, but sometimes water as it issues from the ground does not contain enough oxygen. Fish require a great deal of oxygen. They can not get it from the air like man but must take it out of the water. Oxygen of the air is readily absorbed by water so that if the water is sufficiently exposed between where it emerges from the ground and the hatchery, it can receive the required oxygen. An aid to oxygen absorption is to have the water fall over a dam or flow in ripples over stones.

The Division of Wild Life has two types of hatcheries, one cold-water plant and five warm-water plants. In a cold-water plant trout eggs are collected and hatched in trays suspended in water troughs, while in a warm-water plant the fish spawn in pools where their eggs remain to hatch and the young to develop.

At Summerville, where the cold-water plant is operated, speckled or brook trout and rainbow trout are kept in pools to supply eggs but a part of the needed supply of roe is obtained from Federal hatcheries.

At spawning time these two species of trout are netted, and by careful manipulation with the hands the female yields its eggs and the male its milt. If properly performed the process of "stripping" does not injure the fish. They are released unharmed into the pools.

The eggs and milt combined, the hatching process gets under way. The fertilized eggs are placed in trays which are submerged in water carried through the hatchery in troughs. The bottoms of the trays are made of woven wire cloth with a mesh that holds the eggs but sufficiently open to allow the newly hatched fish to fall through. Each tray will hold 10,000 to 15,000 eggs. Dead eggs are removed as soon as detected and replaced with fresh eggs to retain the original number in the tray.

Depending on the temperature of the water, rainbow trout eggs reach the eye stage in about 13 days and are hatched in 35 to 38 days, while brook trout require a longer period and hatch in 50 or more days.

A pond of a warm water hatchery near Macon, Georgia, where mature fish lay eggs and young are hatched and fed until large enough to be placed in public streams.

After the eggs of trout are hatched in trays submerged in troughs carrying fresh water, the young fish are placed in rearing pools shown above. When they reach fingerling size they are released in public streams by the Division of Wild Life.

When the newly hatched fish or fry fall through the mesh of the tray into the trough, each has a yolk sac attached to supply a few days' nourishment. The sac remains on the fry of the trout from 25 to 30 days, becoming smaller each day. Before the sac has entirely disappeared the fry rises in the water in quest of food which the fish culturist must begin to supply.

The fry is fed five to six times a day and after they attain fingerling size, 1 to 1½ inches long, they are fed less frequently, usually about three times a day.

While various foods are used, pulverized beef and sheep hearts, or pulverized beef and sheep livers are considered excellent and are quite generally employed. Adult trout kept for breeding purposes are fed any kind of raw meat and fish in pieces as large as half an inch in diameter, also cooked mush and other foods.

While fry is shipped by some hatcheries to be placed in rearing pools the practice has been discontinued in Georgia because of the high mortality resulting when transported and planted at this stage of development. Only fingerlings are now distributed. They reach this size by March of the year following spawning, and it is in March that most shipments of trout are made to stock streams in Georgia.

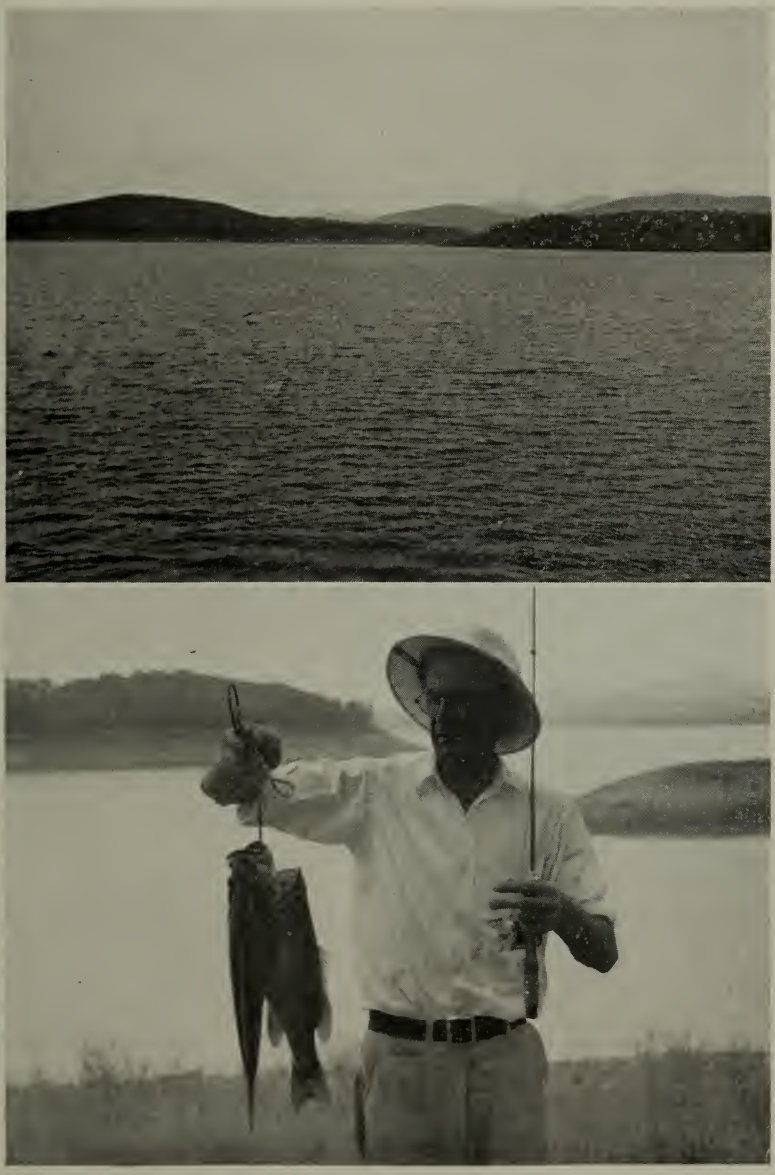
The Division of Wild Life is permitted to place young fish only in public streams. Citizens who have private lakes and ponds to be stocked can get fish from Federal hatcheries which the state Division of Wild Life will help to distribute.

Fingerlings kept for breeding purposes at a cold-water hatchery are placed in rearing pools or raceways. When any die they are promptly removed from the pools and as they grow to larger sizes they are given greater water space.

When shipping time arrives the fingerlings are carefully caught in nets, usually in shallow water after the pools are drained. They are then placed in milk cans and quickly conveyed to points where they are to be released into the streams.

Survival of the young fish depends upon where they are released or planted. They should be placed in shallow, shady waters of small streams where large fish that might prey upon them do not stay. As they grow larger and are better able to escape their predators, they will venture out into deeper waters. Where ponds or lakes are to be stocked the young fish should be placed in small stream tributaries or shallow reaches of the waters.

Not only should young fish never be poured into deep water, but all should not be released in one place. They should be placed in desirable places widely separated.



Hydroelectric power lakes in the mountains of North Georgia, with fisherman in foreground displaying bass he has hooked.

In the warm-water hatcheries mature fish and the young grow up together. Because the mature fish are regularly fed, they do not prey on the young.

During the year ending March 31, 1938 the Division of Wild Life had planted about 10,000,000 fish, a considerable portion of which were not fingerlings but fish taken from ponds where they were dying because of unfavorable conditions, or from artificial lakes that were to be drained and the ground used for other purposes.

Each year the contribution of millions of fish reared in the hatcheries and placed in streams of Georgia will thrive, and if allowed to mature, will replenish the waters and afford both a source of food and pleasure to fishermen.

CHAPTER V

USEFULNESS OF BIRDS TO MANKIND

More than 800 distinct kinds of birds belonging to 75 families are found in the United States, most of which are represented in Georgia either as residents or migrants.

Birds make their greatest contribution to mankind as insect destroyers. If it were not for birds, insects would increase to such great proportions that heavy losses to field crops, orchards and forests would result. Birds also feed on the seeds of grasses and weeds, reducing competition of such growth with cultivated crops. Those who note that insect damages to crops and orchards are increasing year by year, will probably find that few birds are seen in their vicinity.

Flickers, blackbirds, robins and thrashers seek their insect food near the ground; woodpeckers, nuthatches, titmice and chickadees closely search the trunks and limbs of trees; vireos and warblers scan the leaves and probe the flowers; and flycatchers and swallows catch insects on the wing. Birds follow the plow to feed on upturned grubs. They visit the vineyard, the gardens and the field crops. Daily enormous quantities of insects are taken into the craws of the foraging birds and much is carried in the beaks to the newly hatched young in the nests.

Where there is an outbreak of insects there the birds gather in numbers, with the result that the insect damage is lessened. An instance of this has been recorded in Utah where an outbreak of the alfalfa weevil occurred. As many as 45 species of birds were found attacking the insects. The craw of the blackbird contained 442

weevils, the killdeer's stomach, 383 weevils and 376 in the larva stage. The much despised English sparrow was the most effective enemy of the insect.

Of particular interest in Georgia is what part birds have in controlling the cotton boll weevil. Sixty-six kinds of birds are known to feed on the insect. It is thought that the orioles are the most effective. As many as 41 boll weevils have been found in the stomach of a Bullock oriole. Swallows catch boll weevils on the wing. The eaves swallow's stomach revealed as many as 48 weevils.

Occasionally wheat, rye and oats have outbreaks of the green aphis at a time when birds are migrating. Instances are reported where

Wild turkey photographed in the woods of South Georgia. Hunters find it difficult to get in shooting distance of this alert bird and will agree that this is a rare picture.

flights of goldfinch, vesper and chipping sparrows have swooped down, devoured the insects and saved the crops.

The most destructive forest insect in Georgia is the southern pine beetle, the larvae of which feed on the cambium and often destroy the tree. One may see a woodpecker studiously locating a larva by the sound the grub makes where it is hidden. Having decided, the bird quickly drills and removes the grub.

The woodpecker is the only bird that digs through the bark to feed on insect larvae. Counts have shown that fully 75 per cent of western pine beetles have been destroyed by woodpeckers.

Whippoorwills and nighthawks are almost strictly insect eaters. The humming bird devours the minute insects they find in flowers and catch on the wing.

Among the 31 members of the flycatcher family, the scissortail, kingbird and phoebe get 95 per cent of their food from insects.

About 100 species of sparrows, while essentially seed eaters, consume some insects and are to be regarded as beneficial.

Tanagers and swallows are tireless destroyers of an immense quantity of insects. Ten kinds of the smooth, green-coated vireos, and 55 kinds of warblers with their varied and brilliant plumage, are classed as the special guardians of tree foliage, eating caterpillars, scale insects, plant lice (aphis) and other insects injurious to the tree.

Wrens are almost wholly insectivorous. The flickers, or yellow-hammers, are great destroyers of ants. Cuckoos, or "rain crows," feed largely on caterpillars and grasshoppers.

Some birds like the dove and pigeon feed on seeds, but the dove especially is valued for sport and food. Jays and crows are of little value but are credited with about as much good as harm.

Birds that are useful in destroying insects, such as the blackbirds, may become so numerous as to be destructive of grain crops, and their numbers may have to be reduced at times.

Experience has shown that efforts to attract birds and increase their numbers are rewarded. The chief methods of attracting birds are the suppression of their enemies, providing food, water and nesting places. Those who have made bird houses and water basins, scattered food and kept prowling cats in place, know how much birds can be attracted.

GAME BIRDS. The bobwhite is much desired and very widely distributed in the state. Second in general popularity and widely distributed is the dove. The marsh hen on the coast affords in season sport for hunters. Less abundant, the wild turkey is a sportsman's delight, especially in South Georgia where it is found in greatest numbers.

Migrating geese and duck, hunted under Federal regulations, afford very popular sport on the coast, in lakes and ponds and along streams.

CHAPTER VI

THE BOBWHITE

Every farm in Georgia can have its conveys of bobwhite, but their presence and their abundance on the farm depend on something being done about it. Conditions favorable to the bobwhite must be established and maintained, and when this is done the bobwhite will appear and thrive.

No bird provides better sport for the hunter, and while sport is uppermost in one's mind when the bobwhite is mentioned, its greatest value to the farmer is contributed by its destruction of insects injurious to agricultural crops. In fact, one may well afford to propagate quail for crop protection alone.

The object of this discussion is to tell how to have the bobwhite on the farm, or if already there, how to have it in greater abundance.

AN ASSET TO THE FARMER. The craws and gizzards of more than a thousand mature and young birds were carefully examined by the U. S. Biological Survey to determine what the bobwhite feeds upon. It was found that 14½ per cent of the food of adult birds is animal matter, running as high as 21½ per cent in the summer when insects are most abundant. Among the insects consumed were grasshoppers, crickets, locusts, beetles, termites, katydids, stinkbugs, squash bugs, chinch bugs, cotton stainer bugs, harvest flies, leaf hoppers, plant lice, moths, ladybird beetles, wood borers, seed weevils, flies and gnats of various kinds, ants, bees, wasps, spiders, mites, ticks, worms, snails and many other forms of animal life.

Several of the above insects are injurious to crops and some to animal life. The bobwhite is, therefore, a friend to the farmer in destroying these pests.

But this is not the only way the bobwhite can befriend the farmer. This bird is a heavy feeder on weed seed and reduces the amount of weeds that compete with farm crops. The U. S. Biological Survey found in the craws and gizzards evidence that about 85 per cent of the food of bobwhites is from vegetable sources, mainly seeds. Among the weed seed eaten are those of sheep sorrel, smartweed, knotgrass, pigweed, chickweed, mallow, milkweed, morning-glory, dodder, pennyroyal, plantain, madder, ragweed, thistles, dandelion, coffeeweed, foxtail, broom sedge, wire grass, crab grass, and Johnson grass. As a matter of fact, practically all kinds of weed seed are consumed.

The farmer, of course, is entitled to the sport of hunting the bobwhite and the benefits of the excellent food thus provided for his table. Because of the prolific breeding habits of the bobwhite when proper conditions are provided, it is possible to shoot a considerable number each year without decreasing the next season's normal supply.

While it is unlawful to kill bobwhites to sell, it is possible for the farmer to obtain a direct revenue by posting his farm and charging sportsmen for hunting rights.

PROTECTIVE COVERING. One of the essentials for creating favorable conditions for bobwhites is "refuge cover." This may be provided by thickets and vine tangles which the bobwhite can reach when pursued by its natural enemies, especially the hawks. Since the bobwhite does not forage more than two or three hundred yards from such protection, it is an advantage to have refuge covers scattered about the farms so as to extend the beneficial foraging of the birds.

It is undesirable from the standpoint of bobwhite production to clear up growth in fence rows, along roadsides, in gullies, and to destroy undercover at edges of forests, since it deprives the birds not only of safety but of desirable nesting places, and so much so that bobwhites are likely to move away from such cleared areas to more favorable places.

Abandoned fields grown up to broom sedge or thickets are not favorable for birds because of the limited amount of feed available, and because the rat, an enemy of bobwhites, is fostered by broom sedge fields. Ideal sites are where there are cultivated fields with refuge covers nearby.

PROVIDING FEED FOR THE BOBWHITE. Mention has already been made of some of the insects and weed seed consumed by the bobwhites in discussing the advantages of bobwhites on the farm. These foods are provided without effort on the part of the farmer, but to make sure that the bobwhite is well provided with food, it is worth-while to know something further about its feeding habits, and in so far as possible to provide some additional food.

The bobwhite is fond of cowpeas, soybeans, corn, millet, sorghum, wheat, and other small grains, but it gets most of this food by gleaning the fields after the crops are harvested. In so doing, however, it does not neglect to feed on the seed of weeds that have grown in the crops.

On game reserves, where the largest number of bobwhites is desired, it is reported that small patches of beggarweed, lespedeza, mil-

let, cowpeas, sorghum, and other small grains are sown for the use of the bobwhite, but authorities state that on the average farm where some of these crops are produced, and others grow naturally, feed patches need not be sown. It is, however, a good practice to sow lespedeza in gullies and on spots not used for cultivated crops. These sites usually have covers for safety and for nesting, thus affording an added reason for planting lespedeza in such places.

It is also good practice to leave a few rows of small grain when harvesting along the edge and in the corners of fields.

Bobwhites are also fond of small, wild fruits and mast of trees. They feed on the fruit of black cherry, dewberries, sassafras, blackberries, wild strawberries, wild plums, huckleberries, mulberries, black gum, dogwood, sparkleberry, wild grapes, gallberry, sumac, etc. They eat acorns, especially the smaller kind, also chinquapins, pine seed, maple, ash, and other tree seed.

It will be rarely necessary to plant any shrubs or trees to feed the bobwhite, but when planting shrubs, trees, or vines to stabilize gullies, it is well to use the kind that will feed these birds; and before cutting out growth along gullies, fence rows, and roadsides, it is worth while to consider the needs of the birds.

Destroyers of Bobwhites and Their Eggs. Hawks are usually considered the chief enemy of quail. This is especially true of the Cooper hawk, otherwise known as the "blue darter" or "blue tail" hawk. The sparrow hawk should not be killed since it is mainly an eater of grasshoppers. The broad-winged hawk is beneficial. Red-tailed, red-shouldered, and marsh hawks are eaters mainly of snakes, rats, and other animals that prey on bobwhites and their eggs, and the few quail caught by such hawks is more than offset by the good they do. The swift flying Cooper hawk should therefore be slain for the protection of bobwhites.

Owls are charged with killing bobwhites, but the evidence is that they kill very few, and are more of a protector than enemy by destroying snakes, rats, and skunks that are harmful to birds. Because the Great Horned Owl is destructive of turkeys and chickens, as well as birds, it is well to destroy it.

Roving turkeys feed on bobwhite eggs, and chickens ranging the fields will destroy nests. Both carry poultry diseases to the bobwhites.

Among the mammal enemies are roving house cats and dogs. They take heavy toll of birds and eggs. Cats are especially destructive

when they catch birds on their nests while the young are hatching. Dogs destroy eggs.

Skunks, both the striped and spotted (civet cat), are harmful to quail production. The spotted is the more destructive of the two. Skunks feed on eggs mainly. They make a hole in an egg and lick out the contents. Some believe this to be the work of crows, but the crow has not been found to be a serious menace.

The opossum eats both birds and eggs, shell and all. Raccoons are fond of eggs, but do not range widely.

Weasels destroy field rodents, and also destroy quail, but they are usually not numerous enough to cause serious trouble to birds.

Cotton rats, or "field rats," especially abundant in broom sedge fields are very destructive of eggs. These can be trapped or poisoned, or driven out by plowing up broom sedge fields.

If two or three eggs are missing from a nest every day or two and the nest is otherwise undisturbed, a snake is the probable invader. The blacksnake and the coachwhip among the racers, and rat snakes, or chicken snakes among the Colubers, eat both eggs and young quail. In the list of snakes known to be harmful to bobwhites are those known locally as the red chicken snake, white oak runner, bull snake, and king snake. The blue jay helps one locate snakes by its cry of alarm.

Among quail enemies the red ant may be listed; they bite and annoy a bird while it is incubating the eggs, sometimes driving it away. If the nest is invaded while the birds are hatching, the ants do greatest damage by entering the pipped shells and literally consuming the unhatched chicks. A control measure recommended by specialists is to discover all anthills within fifty feet of a nest and treat them with kerosene or flea compound rosin oil, by injecting the material through the surface openings of the ant nests.

Bobwhites have their mites, lice, ticks, red bugs, and intestinal parasites. Some of these are carried to wild quail by wide ranging farm poultry, and the only thing a farmer can do about bobwhite diseases and parasites is to confine farm fowls as much as possible.

Bobwhite Increase. One might conclude that the bobwhite has so many natural enemies that its propagation on the farm is beset with great uncertainty; but when one understands that the bobwhite is capable of producing two or three broods a year and that the hen has been known to lay as many as 139 eggs in a season, one will realize that extermination of the quail is not easy. But while capable of such performance, investigations have shown that bobwhites do

not go to this length in reproduction in the wild state, unless their effort to bring off their first brood is unsuccessful, or their second effort has failed. If they are successful with one brood, they seem content.

An average set consists of 14 or 15 eggs, of which about 85 per cent hatch. Even at this rate of increase it is evident that only a pair of birds is needed to replace each pair of the previous year to maintain a production level. Plenty of birds will, therefore, be available for increasing the number of broods, with several to spare for the sportsman.

BOBWHITE STAYS CLOSE HOME. The bobwhite is a home lover. The U. S. Biological Survey and the Co-operative Quail Investigations used leg bands for identifying birds and studied their movements in southern Georgia and Florida. It was discovered that a great majority of the birds were found the next year within a mile radius of where they were banded, and about half of those taken were found within half a mile, and only about 2½ per cent had made journeys of three miles or more. Thus, it will be seen that an effort to promote bobwhite production on one's farm will be rewarded, as might not be the case if the bobwhite was migratory in its habits.

The information presented in this study of wild life is drawn largely from the published findings of Herbert L. Stoddard, the best known authority on the bobwhite of the Southeast.

CHAPTER VII

FOOD AND FURS FROM WILD ANIMALS OF GEORGIA

Food and furs are the chief contribution of wild animals to man. Early settlers depended largely on wild animals and fish to supply meat, and used skins of wild animals for some of their articles of clothing.

Today the value of the food obtained in Georgia from the rabbit, opossum, squirrel and deer is not known but must amount to several hundred thousand dollars annually.

But Georgia is evidently not making use of its opportunity to sell the furs of animals killed for food, nor the opportunity to grow fur bearing animals commercially. The shipment of skins of wild animals during the period of December, 1937, and January, February and March, 1938, amounted to 22,378 skins. Doubtless many more rabbits and opossums were slain than this but the records show very

few pelts of these animals marketed. The raccoon leads by far all other wild animals in the number of pelts shipped, the number being 13,256. Others in their order are: opossum 4,314; mink 2,024; muskrat 993; skunk 826; gray fox 472; otters 171; red fox 143; brown weasel 50; wild cat 31; civet cat 30; deer 26; polecat (spotted skunk) 15; bobcat 13. Only a few skins of rabbit, mole and bear are reported shipped.

DEER. The most common species of the deer family in Georgia, and native to all parts of the state, is the Virginia deer. It is still present, being more abundant in the extensively wooded areas of South Georgia than anywhere else in the state. In the more thickly populated areas the Virginia deer has disappeared. Even in the mountains where large areas of woodland and favorable natural conditions exist, deer have been hunted so persistently that they have become almost extinct. With favorable conditions in Georgia for deer, great opportunities exist for providing delectable venison, and sport for the hunter.

The Division of Wild Life is undertaking to foster the Virginia deer. To this end two methods are employed, one by establishing game reserves and the other by restricting hunting in areas where the deer is found.

For a number of years a deer preserve has been maintained by the state in a national forest of North Georgia. Breeding stock has been placed in this area from time to time and hunting has been prohibited. As a result the number of deer in the preserve is increasing annually. Eventually the surplus will spread outside of the preserve, and if not hunted too closely, deer may become abundant and an important source of food.

In South Georgia where the deer has maintained existence in comparatively large numbers, a state law restricts hunting to the period from November 15 to January 6. No person is allowed to kill more than 2 bucks, or males, during the season and it is unlawful to kill a female.

Deer are browsing animals and feed on various kinds of weeds, foliage of trees, grass, lily pads, lichens and mosses, but they also eat acorns, beechnuts, chestnuts and other mast.

The male Virginia deer has antlers which are shed in the spring but the female is hornless. Alike in color, male and female are reddish-brown in summer and grayish brown in winter. The young are reddish-brown with white spots, the spots persisting for four or five months after their birth.

RABBITS. The most common rabbit in Georgia is the cottontail. Another species, the swamp rabbit is found in the lower part of the state. The cottontail gets its name from the white, cotton-like short tail. Its general color is buff brown with reddish tinge, but varies to brown with a grayish cast.

The swamp rabbit lives in swamps and is grayish brown. It is larger than the cottontail and has larger ears.

Rabbits are a common source of food and their pelts are extensively used for fur linings of clothing.

Virginia Deer Found in Georgia.

SQUIRRELS. Many kinds of squirrels are found in Georgia, such as the red, gray, fox, chipmunk, ground squirrel, woodchuck and flying squirrel, but only the tree squirrels, the red, gray, and fox will be discussed.

The red squirrel is found in North Georgia. The upper part of its body is rusty red, its sides gray, and its underpart is whitish gray. It has a flat, bushy tail about six inches long.

The gray squirrel is the most common in Georgia and is seen in parks where, if not disturbed, they become very tame. Its color is mixed gray and yellowish-brown. Head and back are darker than the sides, limbs and neck which are grayish.

The fox squirrel is the largest of the tree squirrels. Among its distinguishing characteristics are white ears, nose and feet. Its general color varies. It may be gray, buff or black—all these colors being variations of the same species.

Tree squirrels feed on nuts, seeds, berries, buds, grains and occasional insects; their pelts are in demand and their flesh is prized as food.

OPOSSUM. One of the most common and valued wild animals of the state is the opossum. Its pelts find ready market and its flesh is valued by many people as food. It belongs to the marsupial family, the young being carried in an abdominal pouch, as is the case with the kangaroo. The long, naked tail can be wrapped around a limb for support. Its ears are also hairless. The fur has a grizzled appearance due to a mixture of black and white hairs.

The opossum is fond of persimmons, but it also feeds on insects, frogs, small birds, fish and eggs.

FOX. Two species of fox are found in Georgia, the red and the gray, both of which are valued for their furs and for the sport of chasing them with hounds. The red fox is the more common. Its predominant color is red but the same species in rare instances is black and silver, and because of their rarity and beauty the pelts of the black and silver foxes sell at high prices. The gray fox is grizzly gray with tail heavily marked with black.

The fox is found chiefly in the less thickly populated sections of the state, being most abundant in the mountains and in the forested areas of South Georgia. Where abundant it is a marauder of chicken roosts.

RACCOON. Two kinds of raccoon are found in Georgia. The common "coon" is found in all parts of the state, and the Florida raccoon is found in southeastern Georgia. The Florida raccoon has a longer tail, rounder ears, and is yellower in color than the common variety.

Raccoons have ringed tails and a pointed muzzle with wide jowls. The fur, very highly prized, is grizzled gray, brown and black. They prefer to live along streams, lakes and marshes, and usually make their homes in hollow logs. The raccoon is fastidious about its food, usually washing it before eating. It forages at night and its call is somewhat like that of the screech owl.

The raccoon feeds on frogs, fish, small mammals, birds, eggs, reptiles, insects, fruit, nuts, corn, etc.

MUSKRAT. The muskrat's fur is in great demand. It has a close, soft undercoat beneath the long, hard, guard-hairs. When the coarse hairs are removed it resembles the underfur of the fur seal. It burrows into stream banks and builds houses above high water level. Much of its time is spent in the water where it feeds on aquatic plants, mussels, fish and salamanders.

The name is taken from a pronounced musky odor it emits.

OTTER. The skin of the otter is highly prized for its glossy brown, dark fur, with rich colors. The fur is among the most durable. This animal belongs to the weasel family, has a long lithe body, and most peculiar of all, has webbed feet. It is at home on both land and in the water. It has a playful disposition as shown

Black bear of the mountains of North Georgia stopping to investigate the photographer.

by "otter slides" on clayey banks where it slides and dives. Except for man, it is said that it can elude all of its enemies. Its principal food consists of fish, including crawfish, but at times it feeds on birds and small mammals such as muskrats, young beavers, ducks, and occasionally it eats frogs.

MINK. The rich, glossy, dark brown fur of the mink is highly valued. The animal belongs to the weasel group and is about as

large as a house cat, but has a much longer body. Its neck is long and legs short. It prefers to live along streams and burrows in banks, or finds a home in rocks or under logs. Its food consists of fish, frogs, snakes, small animals and birds. When excited it emits an odor that is very pungent.

WEASEL. The weasel is also called ermine, stoat and ferret. The white ermine fur is taken in the winter when it changes from brown to white. The weasel is a slender-bodied, alert, quick-moving animal and a tireless hunter. Its food is normally the blood sucked from other animals, and it is such a wanton destroyer as to kill more than it requires for food. It is a rapacious destroyer of farm poultry. It is curious and bold, hence easily trapped. When trapped it is the epitome of fury and strong odor.

BEAR. The black bear is of minor importance as a source of meat or fur but because it is regarded with unwarranted fear by man, it has almost been obliterated from Georgia. Recognizing man as its chief enemy, the few remaining bears hide in more remote regions of the mountains or in deep recesses of swamps. The bear in the mountains is the typical black bear also called cinnamon and brown bear. In South Georgia swamps the Florida black bear is found. It is darker and larger and has a higher frontal arch than the common black bear. Under only exceptional circumstances will the bear attack man; on the contrary, the bear is so afraid of man that it hides out and is difficult to find.

BEAVER. The beaver is the largest of the rodents. The branch of the beaver family in Georgia is called the Carolina beaver. Once it was abundant throughout the state. At present only two or three colonies survive, these being in South Georgia where they are protected to encourage their increase.

For many years the fur of the beaver was used for making felt for hats and the demand was so great that the animal was almost exterminated.

Peculiar characteristics of the beaver are its broad, bare, paddle-like tail and its webbed hind feet. It makes its home in streams, gnawing down trees which it dismembers to make its dome-like house, and to construct dams for controlling the water flow to suit its convenience.

OTHER FUR BEARING ANIMALS. Other wild animals that provide a limited source of skins for trade are the badgers, wildcats or lynx, civet cat or ring-tail cat, mole, panther or Florida cougar, and skunks.

CHAPTER VIII

GEORGIA'S WILD LIFE LAWS

A summary of laws relating to hunting and fishing, issued by the Division of Wild Life, is as follows:

HUNTING LAWS 1937-8

All hunters are required by law to have proper license to hunt. Licenses may be obtained from Game Protectors, Ordinaries, and other authorized agents. Resident licenses: State, $3.25; County, $1.00; Non-resident license: State, $12.50; County, $5.00. Licenses shall be carried on person while hunting.

It is unlawful to hunt deer or any other game animal or game birds at night.

It is unlawful to buy, sell or offer for sale any game bird or animal; to ship by mail, express, or other means any game bird or animal; or to possess game outside the open season, provided that five days are allowed for the consumption of game killed in legal season.

No person, firm or corporation, may receive game for storage unless person offering to store shall first exhibit hunting license with written permission from the Director of Wild Life, Supervisor of Game Protectors, or district or deputy game protectors.

Permits must be kept by person storing game for inspection by Director.

Storage extension by Director, Supervisor, or district game protectors, provided game is stamped.

It is unlawful to hunt on the lands of another without his permission. See special regulations on foxes below.

It is unlawful to trap any game bird or game animal by any means. It is unlawful to kill, trap, or hunt, or have in possession at any time or at any place within the State, any female deer, provided that special permits for such work may be issued by the Director of Wild Life for propagation or restocking purposes.

It is unlawful to hunt any game bird or animal within one-half mile of any stream, when in flood, until flood waters have receded. Duck and other waterfowl may be hunted at such times if hunted from boats, in legal season.

NATIVE GAME

Species	Open Season—Dates Inclusive	Bag Limits
Quail	November 20-March 1	15 daily, 30 weekly
Wild Turkey	November 20-March 1	2 per season
Marsh Hens	September 1-November 30	25 daily
Doves (in Counties of Troup, Meriwether, Pike, Lamar, Monroe, Jones, Baldwin, Washington, Jefferson, Burke and all north thereof)	September 15-October 15 and December 20-January 31	15 daily Federal Limit
Doves (other Counties of the State)	November 20-January 31	15 daily Federal Limit
*Deer	November 15-January 5	2 per season, bucks only
**Squirrel	October 1-January 15	15 daily
Raccoon	November 20-February 28	None
Bear	November 20-February 28	None
Opossum	October 1-February 28	None

*Deer killed in open season must be reported to the Director of Wild Life within five days after killing.

**The lawful season for hunting cat squirrels is from August 15 to January 15, inclusive, in the following counties only, Catoosa, Chattooga, Dade, Dawson, Fannin,

Gilmer, Gordon, Habersham, Lumpkin, Murray, Pickens, Rabun, Stephens, Towns, Union, Walker, White and Whitfield.

Possession of more than 30 quail prima facie evidence said game was killed contrary to law.

Doves shall not be hunted on, over, or near baited fields; this is contrary to both State and Federal laws.

Lawful to kill bucks only. Deer may not be hunted or killed at any time in the counties of Catoosa, Chattooga, Dade, Dawson, Fannin, Gilmer, Gordon, Habersham, Lumpkin, Murray, Pickens, Rabun, Stephens, Towns, Union, Walker, White, Whitfield, Bartow, Floyd, Marion, Schley, Webster, Chattahoochee, Muscogee, Stewart and Montgomery.

There is no closed season on rabbits or foxes, but license is required to hunt. Foxes may be hunted with dogs only at any time ,but not be trapped except during trapping season, which is November 20 to March 1. No person may chase fox on the lands of another without first obtaining the consent of that landowner. It is unlawful to dig fox from dens or to have in possession any live fox at any time.

Every person on a fox, raccoon or opossum hunt must have a hunting license.

Grouse (Native Pheasants) are protected at all times.

It is a violation of the State Law

To hold in captivity without a special permit any of the above named birds or animals.

To purchase or sell quail or other game birds for food purposes.

For any person, irrespective of age, to hunt in Georgia without a license.

PENALTIES (Code of Georgia, 1933)—Hunting without license: Section 45-205, Page 1293, provides for a fine of $25.00 to $200.00 and all costs of court.

Possession, hunting, killing, or destroying any game bird or animal out of season: Section 45-309, Page 1301, provides for a fine of $25.00 to $200.00 and all costs of court.

Illegal killing or possession of any game bird or animal: Section 45-316, Page 1302, Georgia Code 1933, provides for a fine of $25.00 to $200.00 and all costs of court.

Killing or destruction of non-game birds at any time: Section 45-318, Page 1303, Georgia Code 1933, provides for a fine of $10.00 to $100.00 and all costs of court for each offense. This does not apply to English sparrows, owls, hawks, crows, eagles, ricebirds, field or meadow larks, and buzzards.

FISHING LAWS

A resident fishing license law was passed by the General Assembly of 1937.

Every person is subjected to this license with the exception of children fifteen years old and under and persons fishing in their own county with a pole and line and not using live minnows. License Fee $1.25.

It is unlawful to take at any time from any of the fresh waters any fish except by hook and line, which includes pole, rod and reel, set hooks or trotlines, with natural or artificial bait.

It is unlawful to use at any time in any of the fresh waters any seine, net, trap or similar device to catch fish, except in the case of shad, where netting is permitted between the dates of February 1st and April 20th with the exception of the St. Mary's River which also includes January and for which a special license is required, and for fresh water mullet, carp, gar and suckers during December, January and

February, provided that the mesh of said gill net shall not be less than three inches square or six inches when stretched.

It is unlawful to poison fish by any means whatever, to dynamite fish; to shoot fish with any kind of firearms; to gig or spear fish; to grabble for fish.

It is unlawful to peddle or sell fresh water fish without first obtaining a license ($5.00); or to sell fresh water fish from April 15th to June 1st.

It is unlawful to fish in any of the fresh waters between the dates of April 16th to May 31st, inclusive. This does not apply to trout streams in North Georgia, in the Counties of Catoosa, Chattooga, Dade, Dawson, Fannin, Gilmer, Gordon, Haber-

Game Protectors in uniform get instructions from the Director of the Division of Wild Life (holding paper) and Superintendent of Game Protection.

sham, Lumpkin, Murray, Pickens, Rabun, Stephens, Towns, Union, Walker, White, and Whitfield. The closed season in the streams of these counties is between the dates of November 15th and March 31st, inclusive. However, fishing in all lakes in the above named counties is prohibited from April 16th to May 31st inclusive.

It is unlawful to take in any one day more than 20 Rainbow or Brown Trout or more than 25 Brook or Speckled Trout.

A private pond is a pond which lies wholly in the bounds of a single ownership, and which has no inlet or outlet through which fish can pass to other waters under other ownership. The owner of a private pond, his tenants, and their families, with the consent of the owner, may fish in such pond at any time, provided they comply with the fishing license law. (Acts of 1937.)

It is unlawful for any non-resident in this State to fish in the fresh waters without first procuring a non-resident license ($5.25) from the Director of Wild Life or his duly authorized agent.

It is the duty of any Game Protector to confiscate and destroy any seine, net, trap, basket, gig or similar device when found in use in any of the fresh waters. Fish caught illegally are to be confiscated and given to some charitable institution or hospital.

It is unlawful to obstruct the free passage of fish in any of the streams of this State by means of dams or any other obstacle. It is the duty of the Director of Wild Life to notify any person, firm, or corporation so obstructing the free passage of fish to provide suitable fish ladders or other passageway. Upon failure or refusal of person, firm or corporation to comply, the Director of Wild Life shall have suitable fish ladder or passageway constructed, and the cost of same shall be assessed by the Division of Wild Life against the person, firm or corporation, owning, leasing or constructing such dam or obstruction; and he is authorized to issue execution against such person, firm, or corporation, for all costs of construction of such fish ladder or passageway.

PENALTIES—Killing of fish by the use of dynamite or any other destructive substance: Section 45-507, Page 1310, Code of Georgia, 1933, provides for a fine of not less than $100.00 or more than $1,000.00 and costs, or not less than 3 months or more than 12 months on public works or in the common jail, any or all in discretion of the court.

All other violations of the fishing laws of the State to be fined as for a misdemeanor.

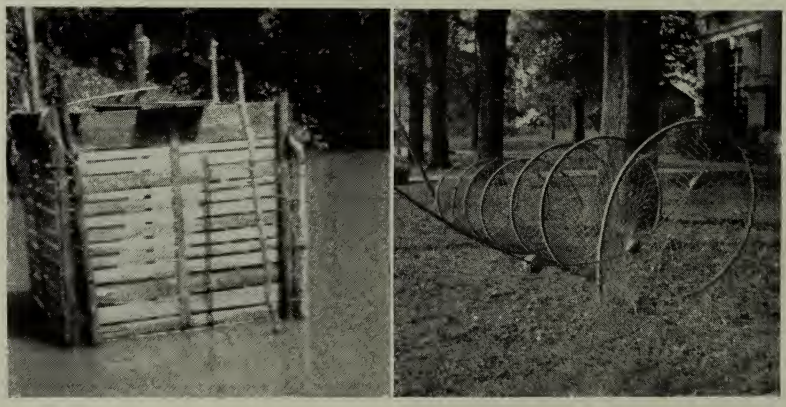
TRAPPING LAWS

Under the Acts of the General Assembly of 1935, it is lawful to trap by means of steel traps or similar devices any of the fur bearing animals of the State in any of the counties during the legal open season for trapping, which is between the dates of November 20th and March 1st.

The following fur-bearing animals may be legally trapped during open season: Mink, Otter, Muskrat, Raccoon, Skunk, Civet Cat, Bobcat, Opossum and Fox.

It is unlawful to trap, kill or molest Beaver at any time.

Bobcats and Skunks may be killed at any time.



Trapping fish is illegal. Left—Fish trap which Game Protectors destroyed. Right—Fish basket seized by Game Protectors.

GEORGIA'S FORESTS AND THEIR DEVELOPMENT

Prepared by

The Division of Forestry

OF THE

Department of Natural Resources

Georgia's Forests and Their Development

SPECIAL TABLE OF CONTENTS

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Georgia's Forests and Their Development

CHAPTER I

WHAT IS FORESTRY?

Forestry is the art of establishing, managing, and harvesting forest crops. Important activities in forestry include the following: The collection of tree seed; growing tree seedlings in nurseries; planting seedling trees on areas where natural reforestation is not possible; protecting forests from fire, insects and diseases; thinning and pruning; maintenance of sustained yields; and proper methods of harvesting and marketing.

The forester who measures the volume of standing timber is called a "timber cruiser." Those who remove logs from the forest are "logging engineers." Those who devote themselves to the improvement of the forests are "silviculturists." Men who patrol the forests are known as "forest rangers." Forest pathologists look after the diseases of trees and forest entomologists are concerned with insect enemies of trees. A dendrologist is one who studies the characteristics of trees for identification or classification.

Botany, which treats of plant life in general, is basic to the science of forestry. Like other green-leaved plants, trees are able to take from soil and air the elements necessary for their growth. Unlike many plants, they do not end their life cycle in one year, but renew growth each spring on their old structures.

Forestry, therefore, deals with long life processes. A tree crop does not bring immediate returns, and care must continue for a number of years to get maximum tree yields.

For maximum forest production the forester must know tree habits, how much soil space and sun exposure trees require, how to influence growth to obtain the desired product, and when to release a crop tree from overcrowded conditions.

A forester is a scientist whose laboratory is the forest. Some foresters are engaged in research to learn more about trees and their habits. Most foresters are, however, applying known facts to forestry practices. Both the state and Federal governments are employing foresters to render assistance to landowners in protecting and developing their forest resources in much the same manner as Federal and state governments are aiding farmers to attain better agricultural practices.

In an effort to conserve forest resources for the future needs of this country, the Federal government has acquired national forests, one of which is located in the mountains of North Georgia. This is known as the Chattahooche National Forest. In this and other similar areas trained foresters are in charge.

The U. S. Forest Service has regional headquarters in Atlanta and maintains close co-operation with the state forestry organizations of the region.

The state forestry work of Georgia is designated as the Division of Forestry which is a division of the Department of Natural Resources. Headquarters are in the state capitol.

The personnel of the Division of Forestry consists of a State Forester who is Director of the Division, Assistant Directors in charge of tree nursery practices, fire control, and utilization, and District Foresters and assistants with headquarters at Gainesville, Macon, Albany and Baxley.

The Division of Forestry operates two tree seedling nurseries which will in 1938 produce more than 25,000,000 young trees. These nurseries are located in Albany and Flowery Branch.

CHAPTER II

IMPORTANCE OF GEORGIA'S FOREST RESOURCES

Sixty-one per cent or 23,000,000 of the 37,583,900 acres in Georgia are classed as forest or potential forest land. In 47 counties forest lands comprise 60 per cent or more of the area; 20 counties have 80 per cent or more; 9 counties have 90 per cent or more. The distribution of forest land by counties is shown in the appendix.

Originally this state was completely covered with forests of pines or hardwoods. After early settlers had cleared forested lands for agricultural purposes and tilled the soil for a few years, they abandoned their fields for freshly cleared lands. Many of the cultivated acres thus abandoned came back to trees by natural reforestation.

An interesting change in the character of Georgia's forests took place as a result of abandoning farm land for new ground. Trees with winged seed, especially the pines, had an advantage in reseeding old fields, and they made such good use of the opportunity that Georgia became more of a pine growing state than it was originally. This modification of tree distribution helped rather than hindered forest conditions, for the pine is adapted to worn-out soils and to various sites, and is one of the state's best revenue producing trees.

Though pines are of major importance commercially, Georgia also has a large variety of other tree species, and is second in this respect only to Florida with its semitropical as well as Temperate Zone flora. Foresters have listed 165 species of trees in Georgia; some of the species in the mountains of North Georgia are indigenous to the far North and some in the southern part of the state are found in the tropics, while trees between these extremes include most species found in the eastern part of the United States.

Stand of virgin longleaf pine, over 150 years old. Known as "Yellow Pine" in trade circles. Heavy, strong timber, valued highly as dimension stock.

In this connection it is well to know that there are more species of shrubs than there are of trees. The difference between a tree and a shrub is that a tree has a single stem with branches forming a crown and a trunk diameter attaining several inches, while shrubs begin branching near the surface of the ground with stems rarely attaining a diameter of more than two inches.

Since trees constitute the state's chief forest resource, this discussion does not include the humbler forest growth, the shrubs, valuable as they are for their beautification of the forest and their food for wild life.

Of the 21,500,000 acres of actual forest land, only about 1,000,000 acres are virgin timber. The present generation is drawing on "second growth," that is, young trees which are the offspring of the old forests. An interesting fact about second growth timber of the South is that because of the quality of its rapid growth it is suited to practically every use for which virgin timber has been employed.

Having many species of trees extremely rapid in their growth, and because of its nearness to wood consuming centers, Georgia has great opportunities for developing forest resources; but Georgia has not made use of its opportunities as it should.

In spite of their neglect and abuse, however, Georgia's trees have survived and are providing jobs in forests and factories for approximately 40,000 people, a livelihood directly to about 200,000 people in the state, and contribute to the livelihood in part of thousands of business and professional men.

The value of primary products such as lumber, naval stores, poles, piling, fuel, veneer, cooperage, crossties, excelsior, and pulpwood, as shown in part by available reports of the Census Bureau, and estimated where not given, is approximately $50,000,000 annually. The value added by the manufacture of primary products into finished commodities brings the total to over $100,000,000 annually.

An important new demand created by paper mills, estimated at 820,000 cords in 1938, will increase as new mills come into operation. This demand will add materially to the number of jobs in the forests and industries and will greatly increase the value of manufactured products.

It is better to think of what can be done than what we have failed to do. The forest resources of Georgia can be doubled in twenty-five years by preventing fires, by allowing abandoned farm land and poorly stocked forests to undergo natural reforestation, and where necessary, by artificial planting of trees and by conservatively har-

vesting forest products. Think of what this would mean in new jobs, more pay rolls, increase in the tax base, and more wealth available for the welfare of all people of the state! But these desirable ends are to be attained only by a change of public attitude toward the forest, possibly only through education. The public schools must face and help to solve the forest problem.

Second growth shortleaf pine, 40 years old—inferior to virgin "Yellow Pine" and not as hard but very useful wood.

CHAPTER III

THE TREE AND ITS GROWTH

Trees grow larger and live longer than any other form of life. The giant sequoias of the Pacific Coast are 3000 to 4000 years old, growing as tall as 320 feet. Some of the oldest sequoias were large trees when Christ was born and were growing when the first pyramids of Egypt were erected. But these trees are giants of the tree kingdom and their great size is exceptional. Other trees, among which is the bald cypress, may attain an age of 1000 years. Many trees in Georgia attain a size suitable for "sawtimber" in forty to fifty years.

CELLS. Like all other living things trees are made of cells. In some respects a tree is like a house made of hollow tiles. The very small cells are hollow and built one upon another. But tree cells are unlike the uniform tile of a house in that they have many shapes. Some are round, some boxlike, some are long and flexible, and others thick walled and rigid. Some cells are capable of dividing when full grown to produce new cells, although by far the majority of the cells of a tree are inert like the hollow tiles of the house mentioned above.

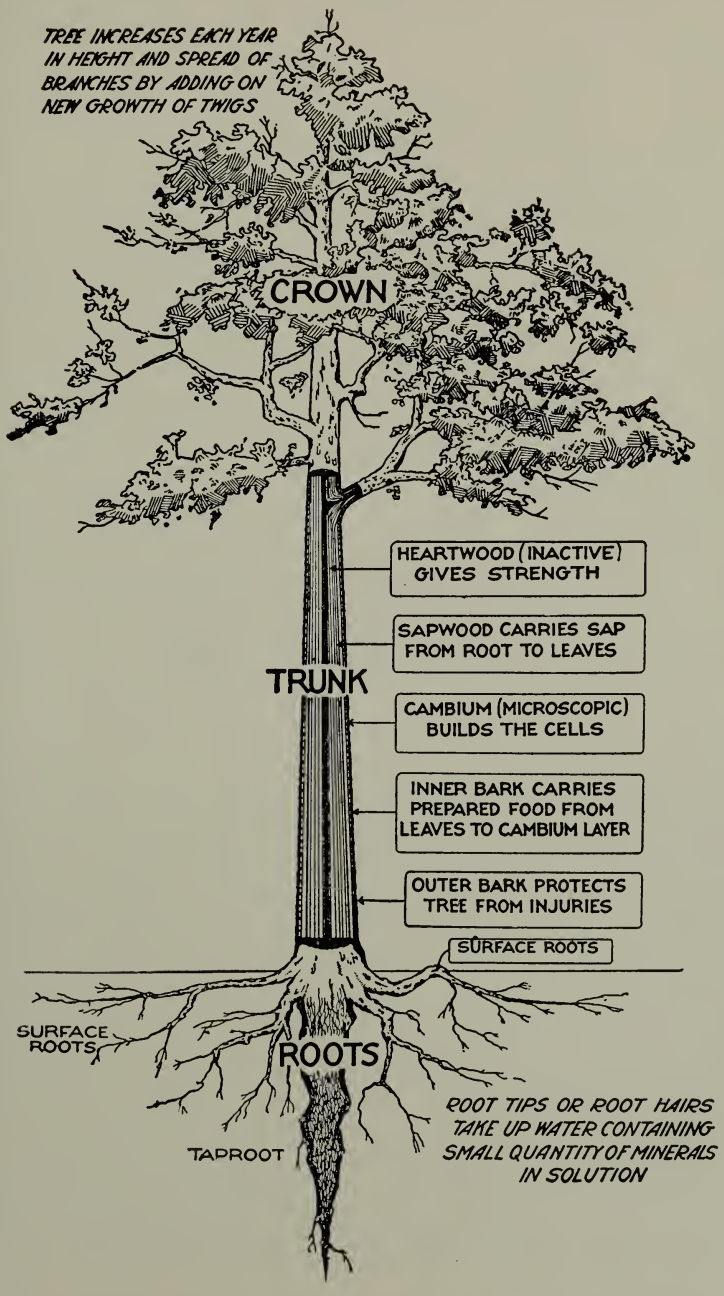
Strong walled cells are essential to make a firm wood structure, and to this end the tree creates a kind of liquid cement called lignin, which infiltrates into cell walls and then hardens to make a strong structure.

SEED. Trees originate from seed just as do flowers. Tree seeds have a hard coat beneath which is compact, starchy material surrounding a small embryo that carries the germ of life.

Seeds are produced on the tree in some form of container. The chestnut and chinquapin seeds are in prickly burrs; cherry, plum, haw, dogwood, holly, and hackberry have seeds with fruity coverings; locust and catalpa seeds are borne in pods; hickory nuts in woody hulls; sycamore and sweet gum seeds in balls; acorns in cups; pine seeds in hard cones; and magnolia and sumach in fruity cones.

Some seeds are equipped with wings with which they fly from the tree on the wind, sometimes as far as half a mile. Common among these are the seeds of the pine, maple, yellow poplar, linden, and ash. The willow and cottonwood trees have downy hairs attached to their seeds to make them buoyant for wind transportation.

Heavy seeds like walnuts, acorns, and hickory nuts have no means of transportation of their own, but thanks to the provident instincts



Compliments American Forestry Association

of squirrels, the heavy nuts are transported and buried in the ground for a future supply of food, often only to remain undisturbed and to sprout and grow.

Water is also a factor in transporting seed over the surface of the ground and along streams. The berry fruits depend largely on birds for transportation to planting sites.

When the warm, rainy days of spring arrive, a seed that has fallen to the ground begins to absorb moisture and swell. From the seed emerges a tender tip which forces itself into the soil. The tip continues to grow into the earth to form roots, while that portion of the tiny seedling above ground develops into leaves and stem.

The cells that are producing primary roots and stem get their food from the mother seed, but as soon as green leaves are formed the seedling is able to gather its own nutriment from the air and the soil. The seedling has then started a life cycle which will be completed, barring disaster, only when it has developed into a great tree.

TREE TRUNK. The tree trunk is the main stem of the tree which supports the crown. The crown consists of limbs, twigs, and leaves. The trunk provides channels for transporting moisture and plant food. It also provides the most valuable commercial products of the tree.

Considering the tree trunk from the bark inward, several well-defined layers occur. First is the outer layer of corky material called bark. The cells composing this layer are inactive so far as tree growth is concerned, but they are very useful in protecting the vital part of the tree from adverse temperatures, damage from fire, mechanical injury, and to guard against entrance of injurious insects or organisms of disease and decay. Under the outer bark is the inner bark which transports plant food down the trunk from the leaves.

Beneath the inner bark is the cambium layer, the cells of which are of the utmost importance in the growth processes of the tree. This is a thin layer of cells, less than 1/16 of an inch thick, yet so vital to the tree's life that in order to cause death one has only to sever the cambium around the trunk with an axe. The tiny cambium cells take the plant food brought down from the leaves, where it is made, and convert it into growth cells of various kinds. In a sense the cambium is the contractor that is building the trees. The diversity of its building may be appreciated when it is noted that it is constructing bark cells on its outer side and an entirely different kind—the sapwood cells—on its inner side at the same time.

Underneath the cambium is a new wood growth called sapwood. These living cells are exceedingly active.

Beneath the layer of sapwood is the heartwood, usually darker in color than the sapwood. The cells of this layer are dead and have hard, thick walls. Heartwood forms a core that gives the tree strength to resist the force of storms.

At the center of the stem is the pith, which in some trees is hardly noticeable, consisting of loosely arranged cells. From the pith the ray cells radiate outward to the inner bark, and serve to transport food materials through the trunk.

LEAVES. Leaves have a very important part in the life of a tree. They manufacture from carbon dioxide taken from the air and plant food materials brought up in the water from the soil, the tree's sap or plant food. They not only take in carbon dioxide but transpire water and waste carbon dioxide. Trees that sever their leaves in the fall are called deciduous, and trees that retain green leaves through the winter are called evergreens. Leaves of different species of trees have distinct characteristics and serve as an important means of tree identification, as will be discussed in the next chapter.

HOW TREES FEED. Green plants, among which are all trees, have the wonderful ability to manufacture their own food. This little known process is one of the most wonderful chemical activities

Hardwood forest in which oaks are prominent. Hardwood brings higher price than pine for lumber.

in the world. The raw products which trees manufacture into food are carbon dioxide gas and water. Only the leaves of the trees take part in this wonderful process which is known as photosynthesis, and which takes place only as a result of energy from the sun's rays. The carbon dioxide which is one of the common gases in the earth's atmosphere enters the leaves through minute openings called stomata. Water and mineral elements are derived entirely from the soil and, therefore, enter the tree through its root system, passing upward through the sapwood into the leaves.

The tiny cells of leaves are filled with a green pigment known as chlorophyll. It is the chlorophyll which imparts the green color to leaves. Through the action of chlorophyll carbon dioxide and water are converted into simple elements of foods, and then by further chemical action these elements are changed into carbohydrates, fats, oils, and proteins—the same materials comprising the food of man.

After the manufacture of food by the leaves, this plant food must be transported to where it is needed. It is carried downward through the inner bark where it is required by the growing cells of the cambium.

While it is easy to understand why water goes down, it is strange that water climbs against gravity all the way from the ground to the topmost leaf of the tree. The principle force at work is called osmosis, or the effort of cells to equalize the concentration of their fluid contents. When water evaporates from the leaves and other surfaces of the tree, as it must for more water and plant food materials from the soil to enter the tree, the cells from which water has evaporated become drier and have a denser, stronger solution. At once osmosis causes moisture to soak from neighboring cells into the drier cells, and in turn, all the cells below yield their moisture. Thus osmosis provides a constant pull and hence the upward movement of water from the soil to the leaves. Likewise sap moves under the power of osmosis wherever there is need for growth material.

It is also thought that capillary attraction may have a part in the movement of water up the tree. This is a force observed operating in an oil lamp, the oil climbing up through the wick to the flame at its top. Capillary movement of water also occurs in the soil, replacing moisture as it evaporates from the surface.

Trees use the same food elements as man requires for his growth. In fact, man's food is created by plant life. We either feed directly on plants or their fruits, or else on animals and their products which have fed on plants.

Unlike man, but like a few animals such as the bear and ground hog, trees take a long rest in the winter known as dormancy, or the sleeping period. Since a certain degree of the sun's warmth and light is necessary for leaf activity it can be readily understood why growth processes of trees must cease in the winter.

Because of this annual break in growth processes of the tree, growth or annual rings are recorded in the bodies of many but not all kinds of trees. By counting the rings in the stump where a tree has been sawed down, one can tell how many years the tree grew. Each ring has a light and dark part, the light being spring growth and the dark, summer growth.

CHAPTER IV

TREE IDENTIFICATION

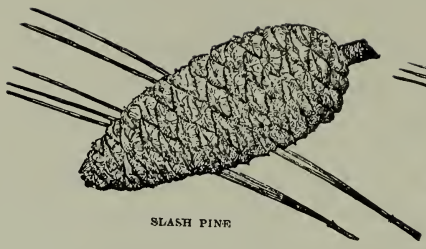
Because each tree possesses certain outstanding characteristics which may cause it to be best suited for certain products, it is important in forestry to be able to identify at least the most common trees. Thus the white oak is well suited for cooperage whereas the red oak is not. Again slash pine is highly valuable for the production of naval stores whereas loblolly pine, although closely resembling slash pine in appearance, is not.

It is desirable to know what trees have long tap roots and what have shallow root systems in order to select proper planting sites. It is also valuable to know what trees grow rapidly and what slowly, what trees require wide space for their crowns and what will do well with minimum space, what trees are shade tolerant and what are not.

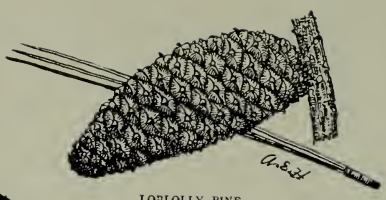
A manual, *Common Forest Trees of Georgia,* issued by the Division of Forestry, illustrates and describes leaves, fruit, buds, bark, and wood, making it possible to easily identify all of the important forest trees of Georgia.

The distinct characteristics of leaves of each tree species make the leaf the chief means of tree identification. Trees fall into two general classes, evergreens and deciduous. Evergreens retain green leaves in the fall and winter whereas deciduous trees drop their leaves in the fall and renew them in the spring.

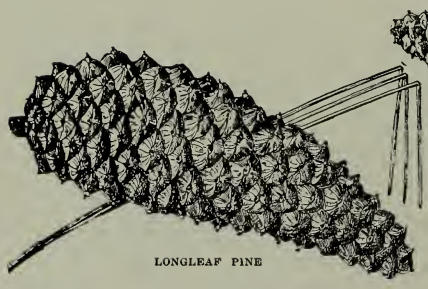
Conifers, so named from bearing their seed in cones, retain some of their green, needlelike leaves during the fall and winter. The sole exception is the cypress, a conifer that sheds all its leaves in the fall.



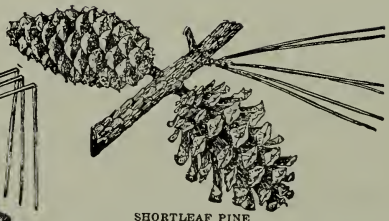
SLASH PINE



LOBLOLLY PINE

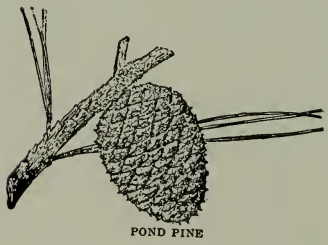


LONGLEAF PINE

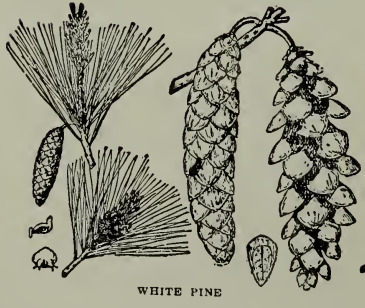


SHORTLEAF PINE

SCRUB PINE



POND PINE



WHITE PINE

CYPRESS

WHITE OAK

POST OAK

WATER OAK

CHESTNUT OAK

SWAMP CHESTNUT OAK

SOUTHERN RED OAK

BLACK OAK

SCARLET OAK

NORTHERN RED OAK

BLACK JACK OAK

LIVE OAK

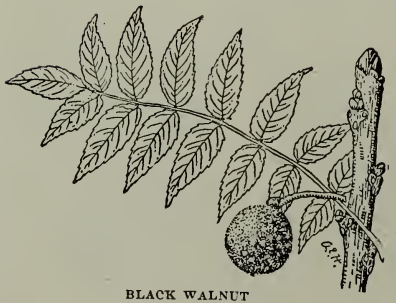
OVERCUP OAK

PIGNUT HICKORY

WHITE HICKORY

BITTERNUT HICKORY

SCALY BARK HICKORY



BLACK WALNUT

PECAN

Broad-leaved trees, another name for deciduous trees, generally shed all their leaves in the fall, but exceptions to be found are the magnolia, holly, and live oak which are evergreen.

Though evergreens retain their green leaves and chlorophyl through the fall and winter, they do not use them for growth during that period. They are dormant like the deciduous trees.

It is interesting to note the great variations in tree leaves. Some leaves are quite broad and long, and at the other extreme are the very narrow, needlelike leaves. Leaf margins are quite different. Some have deep indentures and some are unbroken; some have pointed lobes, whereas others have rounded lobes; notched and smooth margins are found. Some leaves are heart-shaped, others oval, pointed or blunt. For leaf characteristics of some of the most common trees of Georgia, consult the illustrations shown in this publication. The fruits of the trees are also shown.

Not all trees grow on the same site. Along streams and in moist places one can find willow, ash, water oak, river birch, cottonwood, yellow poplar, elm and sycamore in almost any part of the state. In South Georgia one may also expect to find on moist sites, tupelo gum, bay, cypress, pond pine, and magnolia.

On drier sites, such as are provided by sloping lands of hills and mountains, one may look for pines, most of the oaks, hickories, persimmon, sassafras, dogwood, red cedar, ironwood, chestnut, mulberry, haw, and sourwood.

Natural Reproduction—Seed Trees and Their Offspring.

The optimum sites for yellow poplar are the moist, rich coves of the mountains. Georgia is credited with having unsurpassed forests of second growth yellow poplar in the Blue Ridge Mountains.

When collecting leaves for tree identification, also gather tree fruit. Extract seed from their coverings where necessary. Note that some seed have wings, such as those of the pines, maples, and ash, and that willow and cottonwood have silky hairs for wind transportation.

Consider the variations in the nuts of different species of hickories and oaks as an aid to identification of the species.

Note also the different kinds of bark on trees and observe striking differences, the smooth bark of the hackberry and beech, the irregular brown scales of pines, the white bark of sycamore limbs, the papery bark of the river birch that curls in an effort to shed from the tree, the shaggy bark of some hickories and of cedar, the rectangular fissures of the black gum, the light-gray bark of the white oak, post oak, and laurel oak, as distinguished from the dark-gray of other oaks.

Note that the older portions of trees have rougher, more deeply fissured bark than the younger portions of the tree, or young trees.

CHAPTER V

PROTECTING FORESTS FROM FIRE

The greatest hindrance to forest development in Georgia is fire. The Georgia Division of Forestry estimates forest fire losses in the state amount to $5,000,000 to $8,000,000 annually.

Most forest fires are man-caused, very few being attributed to lightning. Those who start forest fires have different motives. Some individuals believe that grazing will be improved by burning. Others seek to kill boll weevils in hibernation. Turpentine operators rake around their trees and burn to decrease the possibilities of an accidental fire reaching the chipped faces and gum of the cups of the trees, and to improve working conditions for their men by removing underbrush. Many fires may be attributed to carelessness. Farmers burning off fields carelessly allow the fire to enter the woods. Hunters who discard burning matches, cigar and cigarette stubs, and who leave their campfires burning when they depart, are responsible for some fires. Still other fires are maliciously started. Those who "burn off" the woods as a rule do so to serve other purposes than the welfare of the forest, and more damage is done to the forest than

any benefit that they may possibly derive. Apparently many people of Georgia do not understand the real damage which fires do to the forest. The chief damage is discussed under five headings, as follows:

(1) *Fires Destroy Seedlings.* Georgia's forests have quite generally fewer trees per acre than the desired number. This is largely due to the fires destroying seedlings each year. Not only would the stands of forests be improved but many abandoned fields would be reforested if nature's efforts were not continually thwarted by fire. Since seedlings will develop into the trees that the young people of today will harvest in the future, every young person should want his heritage of forest wealth protected.

(2) *Fires Retard Growth.* By defoliating the crown and by damaging the cambium layer of the trunk, fires may seriously retard tree growth even if the tree is not killed outright. Obviously the larger the tree, the more resistant it is to fire. But severe fires, caused by dry conditions of the forest accompanied by high wind, are capable of destroying hundreds of acres of trees of the largest size. In Georgia as a whole the average growth in 1934 was only about one-third cord per acre. If protected from fire, the growth of Georgia's forests could quickly be doubled.

(3) *Fires Cause Scars on Tree Trunks Through Which Boring Insects and Organisms of Disease Can Enter.* Frequently forest fires

Destructive forest fire. Note how natural reforestation is prevented by the destruction of the young trees.

scorch the cambium under the tree's bark until it is destroyed; then the bark over the wound falls away leaving the wood exposed to boring insects and fungi of decay. Hardwoods are damaged more than pines which provide gum to protect their wounds until they are healed. The decayed trunk of hardwood trees, with the best portion of the first log rendered worthless, is attributable in nearly every case to fire damage.

(4) *Fire Reduces Gum Yield.* When fire destroys the foliage of pines the production of gum is decreased. Studies made by the Southern Forest Experiment Station revealed that gum yield was decreased 30 to 40 per cent as a result of defoliation by fire.

(5) *Fires Destroy the Cover of the Forest Floor.* The presence of leaves, twigs, and semidecayed matter on the forest floor is very important for several reasons. It provides means for retarding surface runoff during rains, thus causing more water to penetrate the soil. The water of springs and wells and the constant flow of streams are dependent on surface absorption of rainfall. An unburned forest floor provides ideal conditions for absorption and percolation of water into the ground.

If the forest floor is burned, the surface movement of rain water is unrestricted and flows quickly off the slopes in quantities that cause soil erosion. The eroded materials in turn silt up reservoirs and stream beds. Stream beds having been filled, the freshets cause overflows and much damage to bottom lands. The fact that water flows quickly off burned-over forest land also means that a greater

A firebreak to stop fires, or to provide a base for starting a fire to meet an oncoming blaze and stop its advance.

amount of water is released in a short time into the streams and consequently greater floods and greater flood damage result.

The public should be taught to avoid starting forest fires:

(a) By never leaving a campfire in the woods without applying water or covering it with dirt.

(b) By never striking a match in traversing woods or fields without seeing that the match is burned out before casting

Lookout tower for detecting outbreaks of forest fires so that fire fighters may get to and suppress them quickly before they spread far.

it away, and better still, by grinding it into the ground with the heel.

(c) By never dropping a cigarette, cigar stub, or the embers of a pipe on the forest floor or in a field without grinding it into the soil with the heel.

The disastrous effects of forest fires have become so apparent in the past few years that the public is now demanding protection from forest fires. Laws have been passed to prohibit promiscuous woods burning and approximately $155,000 are spent annually by the citizens of Georgia in an effort to protect their forests from fires.

The Georgia Division of Forestry and the U. S. Forest Service co-operate financially with the forest landowners by spending approximately $69,000 annually, in addition to furnishing technical supervision over all of the fire protection work. Obviously that is not enough money to protect the 21,500,000 acres of forest lands in this state and efforts are now being made to obtain more money.

All money and labor employed in fire protection go to construct lookout towers, telephone lines, firebreaks and roads so that fire fighting trucks can get to the fires quickly and easily; to buy fire trucks, fire pumps, tractors and plows for the plowing of firebreaks; to buy other fire suppression equipment and to the hiring of rangers, patrolmen, and towermen so that the fires can be quickly located and fought.

The Georgia Division of Forestry assists landowners in forming Timber Protective Organizations having 25,000 acres or more of forest lands. It is in these Timber Protective Organizations that the towers are built, the fire suppression equipment used and the rangers and patrolmen hired.

Three of these organizations are now controlled by radio. The towermen remain in the lookout towers all day and watch for fires, and as soon as a fire is discovered the towers call the central headquarters over the telephone lines built for that purpose, and by instruments which they have in the towers for the purpose of locating fires, they tell the ranger in charge of the location of the fire. The ranger calls other towers to get a "cross reading" on the fire so as to more accurately locate it, and, after the fire is accurately located, the radio dispatcher calls over the radio to the fire trucks nearest the fire and gives them instructions as to how to proceed and any other pertinent information. Immediately after the trucks get the signals, they go to the fire and with water pumps, "flaps," rakes, and other tools combat the fire. After the fire is suppressed, many hours are

spent by men patrolling the fire to see that it does not break out again, and in extinguishing all burning snags, trees, and stumps.

Education plays an important part in fire protection work. Many people are not aware of the damage that fire does to the forest, and do not realize the benefits to be gained by protecting the forests. The Georgia Division of Forestry works through schools in establishing demonstrational plots and gives advice about protecting the forests. It is then incumbent upon the school children to go back home and carry out the practices learned in school.

In regions of the state where no large forested areas exist, a system of county fire wardens is used by which community groups are organized to fight any fire that breaks out.

Georgia's record for forest fires is poor, and everybody who realizes what damage forest fires cause must help in the educational program if rapid progress in suppressing the fire evil is to be made.

CHAPTER VI

REFORESTATION

Reforestation of cutover lands or abandoned fields can be attained in two ways—natural reforestation and artificial reforestation. In natural reforestation existing trees distribute seed from which new forest growth results. This process is often hindered by lack of seed trees and by fires, so that many years may elapse before new tree growth is established.

View of the State Tree Nursery at Albany where about twenty million seedlings are now grown each year and sold to landowners at cost of production.

Artificial reforestation is usually carried out by gathering tree seed, growing seedlings in a tree nursery, and planting the young trees on areas to be reforested. Although requiring a larger financial investment than does natural reforestation, this method has advantages in that one can select and grow the kind of trees desired, space the trees properly when planting, and insure a fully stocked stand in a minimum time.

Georgia has many thousands of acres of cutover forest land on which not enough seed trees were left to provide natural reproduction, and there are many other thousands of acres of abandoned farm lands where trees cannot reseed. Artificial reforestation is, therefore, an important practice in Georgia.

The need for artificial tree planting is very generally realized, and in an effort to meet the demand for planting stock, the state Division of Forestry is operating two tree nurseries and is expanding production as rapidly as possible. At no time have the tree nurseries in Georgia been able in recent years to supply the demand for planting stock.

The demand for seedlings is not only to reforest lands for timber production, but for conserving soils that are no longer used for agriculture and are washing away. When trees are planted, erosion of soils is not only controlled but the soils are put to about the only use to which they are suited. It is, therefore, not surprising that the

Slash pine plantation, 6 years in the field, 7 years from seed. Note man in background for determining height of trees. Extremely rapid growth is shown.

Soil Conservation Service is operating a tree nursery in Georgia to supply the tree planting needs on farms being treated for erosion control. The School of Forestry at Athens also maintains a tree nursery in an effort to supply the demand. Although the chief demand for forest planting stock is for pines, public interest is awakening to the desirability of other important forest trees. By the fall of 1938 the Division of Forestry will have available at low costs a supply of the following trees: slash, longleaf, loblolly, shortleaf, and white pines; black locust, white ash, red mulberry, and tulip poplar.

Everyone would like to plant trees and watch them grow, but to insure their growth one must know how to plant them. If it is a pine that is to be planted, it is better that the seedling be used and that it be only one year from seed. Seedlings older than one year are generally too large for easy and economical planting. Pine seedlings grown in a nursery have good root systems and will grow more rapidly than a seedling taken from the forest. Pine roots can

Planting one year old pine seedlings in an old field. The planting iron makes an opening for the seedling taken from the bucket containing water.

by quickly injured by being allowed to dry, so that from the time the seedling is taken from the ground until it is planted in the soil its roots must be kept moist.

The planting hole should be large enough to accommodate the roots without twisting or lapping. The seedling should be placed at the same depth in the ground it was when taken from the nursery bed. The richer soil should be placed around the roots and packed firmly so that there will be no air pockets left.

CHAPTER VII

CARE OF FORESTS

Trees will respond to good treatment and make more rapid growth if cared for by man. The distribution of tree seed, subjected as they are to the variable winds and to the impulses of transporting animals, is usually irregular. Too many seedlings come up in some places and too few in other places. Man can assist by removing some where there are too many and by planting where there are too few. Only where land is fully stocked with properly spaced trees can maximum yields of forest products be obtained.

As long as large trees are making a reasonable rate of growth no thinning is necessary. Growing close together, trees shade their lower limbs. This causes the limbs to die with the result that the trunk has fewer knots in the lumber it produces. But when growth slows up then thinning should begin.

A general rule for spacing trees when thinning is to measure the diameter of the trunk 4½ feet from the ground and add 4; then convert the total to feet, the number of feet thus derived being the desired distance between this tree and any other of the same size. For instance, if the diameter of a tree is 6 inches at 4½ feet from the ground, adding 4, the total is 10. The figure 10 indicates a spacing of 10 feet between the tree measured and another of similar size. Such measurements should be taken for the larger and more desirable trees. Trees are too irregularly spaced for the rule to be more than a general guide. Crooked and diseased trees and any undesirable species should, of course, be removed. Later in the life of the forest, another thinning may be necessary. The trees taken out may be used for pulpwood, poles, fence posts, fuel, and other purposes.

Suppose no thinning is practiced, what would be the result? Trees would continue their struggle. Some will eventually get an advantage and overtop others. The overtopped trees cannot live in the

shade and eventually die. Thus the winners in the forest do their own spacing. But consider what a waste the struggle involves. Much of the growth material that was used by the dead trees could, with proper thinning, have been used for more rapid growth in the trees

Top—Longleaf pine forest in need of thinning—delayed too long. Ordinarily a stand should be thinned when 15 *to* 20 *years old. Note the great number of trees on the site. Bottom—the same longleaf pine forest shown above, thinned to* 200 *trees per acre.*

selected to remain in the forest. By thinning, therefore, forests may be led to greater production of commercial wood.

Pruning is also a silvicultural practice. As already explained, if trees are open-grown, the lower limbs will not die and will remain on the tree indefinitely. It is good forest practice to prune the tree as high as can be conveniently reached with a long-handled axe. Even when trees are close together and the lower branches are naturally killed by the shade, pruning off the dead limbs close to the trunk is advisable so that the limb scars can heal over as soon as possible. Since trees depend on green leaves for growth material, the removal of a large amount of foliage by pruning will slow down growth. It is considered good practice not to remove at one pruning more than ⅓ to ½ of the leaf surface and to make a second pruning later.

Diseases and Insects. Trees are sometimes attacked by diseases and insects. As has been learned, fire leaves scars on trunks of trees through which insects and disease may attack the tree. Hollow trunks are caused by fungi attacking the wood through fire scars or other wounds.

Tree surgeons can stop the decay when it has not gone too far by cutting out the decayed part, treating the wound with an antiseptic and filling the cavity with concrete. This treatment, although desirable for shade trees on home grounds, along streets, and in parks, is of no interest to foresters inasmuch as such detailed care is far too costly to be practical.

One of the great tree disasters of America is the destruction of the chestnut by a fungus. In a few years this disease spread with fatal results to this valuable tree which was a common forest tree of the Appalachian region. The disease was introduced from abroad, began its attacks in the East and rapidly spread. Trees were killed by the fungus damaging the cambium layer.

The Dutch elm disease is another epidemic that is now threatening to wipe out the elms, but it is being attacked with some degree of success and has not yet reached Georgia.

The greatest enemy of the pine in Georgia is the southern pine beetle. Its most destructive outbreaks are found where trees are cut in the summer or where lightning exposes fresh wood. The odor of freshly cut wood attracts the beetles and, by concentrating their attacks, they kill trees—sometimes in great numbers.

The southern pine beetle lays its eggs in the inner bark so that when the grub is hatched it can feed on the cambium. When the grub circles the cambium the tree can no longer live.

An important consideration regarding insects is that they rarely ever attain epidemic proportions unless the forest is damaged by some other cause such as fires, droughts, or floods. Trees damaged

Second growth yellow poplar growing in a mountain cove of North Georgia. This tree grows rapidly, produces long, symmetrical trunks that make excellent lumber and veneer.

and weakened by fires fall easy prey to attacks of the southern pine beetle.

The well known borers or "sawyers" that one can hear "sawing" trees attack only dead trees, and enter trees killed by the southern pine beetle or by some other cause. If the dead tree is not removed soon after it dies it will be riddled by borers.

Many other insects and diseases attack trees but since no great damage is done no measures are taken for their control.

Destruction of Ornamental Forest Trees. The custom of gathering green leaves and red berries of holly for Christmas decoration, and dogwood and azalea branches for their blooms in spring, not only robs the forest of natural beauty but sometimes causes the death of these very desirable plants. It is well to enjoy the beauty of such plants but not to selfishly appropriate it to the extent of maiming or killing the plants.

Perhaps the most effective way to protect the holly is never to purchase it from vendors at Christmas time. Not only refrain from robbing the forest trees of their beauty but make known your disapproval of the practice at every opportunity.

CHAPTER VIII

USES OF GEORGIA WOODS

The commercial forests of Georgia today are new growth, usually referred to as "second growth." Rapidly growing trees, a long growing season, and favorable climate place the South first in timber growing among the forested regions in the country. As a consequence, industries depending on timber supplies are turning more and more to the South.

The primary uses of the forests of Georgia are for lumber, poles, pulpwood, veneer, cooperage, fuel, fencing, charcoal, and naval stores. One of the first (and perhaps the most historic) uses of Georgia wood was that of live oaks near Brunswick in the construction of the famous wooden man-of-war, the *Constitution*.

The long, strong, and straight trunks of longleaf pine find use in ship masts, flagpoles, as well as for beams, sills, and other lumber. In fact pines have contributed more timber products than all other kinds of trees in Georgia. The species of pines that are supplying the most lumber, poles, and pulpwood are loblolly, shortleaf, longleaf, and slash. Some of the finest dimensioned lumber in the world is derived from virgin Georgia pine.

Among the hardwoods, the white oak is important in providing hard, beautifully grained wood capable of high polish and favored for furniture, flooring, interior finishings, desks and cases. For many of the same purposes, red gum, wild cherry, and black walnut are also used. White oak is the favorite wood for tight cooperage; that is for making watertight barrels. Makers of athletic goods and handles for tools or farm implements, and manufacturers of vehicles desire wood that is hard and flexible. This they find in ash and hickory. Railroads want crossties from durable, strong wood that will hold spikes. This they find principally in oak, cypress, and pine. Poles for supporting telephone, telegraph and electric power wires must be strong, with but slight taper, and durable in contact with the soil. The requirements are met in chestnut, black locust, cypress, cedar, and (when creosoted) the pines. The farmer needs for fence posts the kind of wood that is resistant to decay in contact with the ground, and finds black locust, mulberry, cedar, heart pine, and sassafras are best for this purpose. Textile mills require many spools and bobbins made from hard, close-grained wood that does not split, and will stand hard wear. This is provided by dogwood, persimmon and ironwood. The same kinds of wood are also desired for golf club heads. The turner who shapes or carves round posts, pillars, pedestals, or bows desires fairly close-grained timber and uses for this purpose the yellow poplar, tupelo gum, and beech. For veneer, used in making desks, household furniture, doors, and interior finishings, the producer wants beautifully grained hardwoods, and uses oak, maple, walnut, red gum, cherry, and birch. For baskets, light, small boxes, and crates, the veneer manufacturer uses yellow poplar, cottonwood, black gum, tupelo gum, and basswood. Cedar is favored for chests and lining of closets because of an odor that moths reputedly avoid.

Lumber Industry. Normally Georgia has between 1000 and 1500 sawmills in operation. A few are large mills receiving logs shipped many miles; but most of them are small, portable mills that set up near a forest and when the local supply of logs is cut move to another source of logs.

According to the latest available information from the Bureau of Census the production in 1936 of 951 sawmills in Georgia was 872,476,000 board feet. (A board foot is one inch thick and one foot square.) Of this amount 766,010,000 board feet were cut from softwoods (pines) and 106,466,000 from hardwoods. According to the same report the average value of pine lumber at the mills was $16.81 per thousand board feet, and the average value of

hardwood lumber at the mills was $21.27 per thousand board feet.

Sawmills are scattered over all the state. No one who is out on the roads or streets fails to see and smell the odor of freshly cut lumber moving to points where it is in demand. Unfortunately many trees of small diameter are sawed. Timberland owners do not seem to realize that small thrifty trees are making rapid growth of commercial timber. Left alone to grow to larger sizes they will be much more profitable both to the timberland owner and the sawmill operator. Good forest management calls for harvesting mature trees and trees that should be removed in the process of thinning to improve the forest.

An operation that is frequently associated with sawmills is planing mill products. In 1935, according to the U. S. Bureau of Census, 84 such mills reported 445,259,000 board feet planed by 1,716 employees in Georgia.

VENEER AND PLYWOOD. A comparatively new and very promising use of wood is veneer, obtained by rotating a log against a long blade so as to make a continuous sheet of thin wood. It has been called "unwrapping the tree." This thin sheet of wood is generally glued to less valuable wood in the manufacture of tables, desks, pianos, and radios so as to give a beautiful outside appearance at low cost.

Plywood is made of layers of veneer glued together at cross grain. Strong wood is thus formed with minimum weight and is especially valuable in airplane construction. Recently the Forest Products Laboratory of the U. S. Forest Service completed a design for houses to be made completely of plywood at very low cost. Other veneer manufactured in Georgia from gums, yellow poplar and the hardwoods is used for making berry boxes, peach, apple, and vegetable baskets and crates. When one sees a load of what appears to be short logs, it is very likely that these logs or "bolts" are going to a veneer or cooperage manufacturing plant.

COOPERAGE. Two types of wooden barrels are manufactured in Georgia. These are slack cooperage for rosin and tight cooperage for turpentine. The slack cooperage is usually made of pine with wire serving as hoops. The tight cooperage must be water tight, and is usually made from white oak with steel bands for hoops.

The census of 1935 showed there were twelve cooperage plants in Georgia employing 235 people, with the value of the products placed at $964,171.

BOXES. Fourteen wooden box factories in Georgia in 1935 employed 2,168 men and produced boxes valued at more than $3,000,000.

TURNERY. Manufacturers that carve wood into a diversity of shapes for various uses such as bedposts, stair posts and porch pillars operated four plants, employed 186 men and produced wares valued at $147,000 in 1935.

WOOD PRESERVING. Nearly all telephone, telegraph, and electric light poles used today have received a treatment of creosote. Creosote prevents decay. It is applied to the poles under high pressure to force it deeply into the wood.

Formerly only woods highly resistant to decay such as black locust, chestnut, cedar and cypress were used for poles, but when they became scarce creosoted pines came into use. Seven creosoting plants in 1935, employing 466 people, were using poles valued at $2,453,362, and were adding a value of $839,629 by creosoting.

EXCELSIOR. Georgia has two excelsior manufacturing plants but the census gives no data on production. One of these plants is among the largest in the country and converts pines into wooden ribbons, known to everyone as packing material.

OTHER WOOD INDUSTRIES. Information on other wood industries for the state as a whole is not available, but the U. S. Forest Service has released information for the naval stores area of South Georgia which shows that 46,000,000 board feet of veneer, 1,919,800 crossties, 4,082,000 fence posts, 160,300 poles, 35,100 cords of wood for cooperage, 171,000 cords of fuel wood, and 78,400 cords of wood for miscellaneous products were harvested in 1934 in the 57 counties comprising the area.

Naval stores and pulpwood are reserved for separate discussions.

FUEL. Most of the farm families and a number of village and town families depend upon forests for fuel. Information gained in other southern states indicates that the average family uses 14 to 16 cords of wood a year. Some farm families have so little woodland that they use coal for fuel. Those who buy wood pay $3.00 to $4.00 a cord delivered. It is probably conservative to figure that a cord of fuel is worth $2.50 to the farmer. Figured on this basis, Georgia is using wood valued at $8,000,000 or more as fuel each year.

A well-kept, well-stocked forest may grow a cord of wood annually, but few acres are doing this, so that on the average a Georgia farmer should figure on having 40 to 45 acres of woodland for a perpetual supply of fuel.

CHAPTER IX

NAVAL STORES

Georgia produces 57 per cent of the naval stores output of this country and obtains $16,000,000 or more annually for its efforts. According to the latest available census figures, 14,537 people were employed at the 497 distillation plants at salaries and wages amounting to more than $8,000,000, using materials valued at $10,266,442 and adding a value by manufacture of $6,134,331. This does not include the chippers and other woods operators for which no report is made.

Naval stores are rosin and turpentine obtained from the gum exuded by slash and longleaf pines when they are chipped. Only slash and longleaf pines of the ten species of pines found in Georgia yield gum in sufficient quantity to be commercially profitable. The two naval stores species grow mainly in southern Georgia.

Gum is not pine sap such as the sweet, watery sap of the maple tree from which maple sugar is made but is a sticky substance which exudes from the tree as a result of a wound. Certain cells of the pine are latent until they are called upon to bathe a tree wound with gum—the tree's method of protecting its wound against attacks of insects and organisms of decay. The tree applies the gum to its wounds as one would an ointment, as a protection until new bark is formed.

Taking advantage of this defensive provision of the pines, the turpentine operator chips through the bark and makes a narrow wound that results in gum production. When pines were first chipped for naval stores, only large trees were used and a deep cut or box was made in the tree for collecting gum. Dr. Charles H. Herty of Georgia devised the present method of hanging cups to the tree which revolutionized the industry by making it possible to chip small trees. This method consists of using metal strips called either aprons or gutters for guiding the gum into cups suspended from the trunk of the tree by nails.

Once a week, as a rule, in order to stimulate a fresh flow of gum, the chipper removes another narrow strip of bark and wood. The active naval stores season continues throughout the year except for the winter months of December, January, and February.

It is customary to remove 32 chips each year. From ¼ to ½ inch of wood is removed at each chipping. Thus, after several years working, a "face" may extend up the tree for 8 to 10 feet. The

liquid gum and the hardened gum which forms on the face are collected periodically from the cups, placed in barrels and hauled to a still where rosin and turpentine are produced from the crude gum.

It has been recommended by the United States Forest Service that no trees smaller than 9 inches in diameter be chipped; but in case there are too many trees on an acre, smaller trees may be chipped before they are removed as thinnings and sold as pulpwood. Chipping of trees smaller than 9 inches in diameter is of doubtful value due to the small gum yield from timber of this size. At least one-third of the bark of a tree should be left to assure a rapid healing of the wounds.

The yield of gum is usually roughly in proportion to the leaf surface of a tree for the reason that the green leaves provide materials from which gum is made. Those who grow pines primarily for naval stores, therefore, desire a spacing that will permit trees to have comparatively large crowns.

The revenue obtained from naval stores is in a sense a surplus income since the timberland owner still has the wood to sell after the gum has been harvested. This gives the slash and longleaf pines exceptional values.

View showing pines chipped for their gum from which naval stores—rosin and turpentine—are produced. The trees are in their fifth year of chipping. A narrow strip of bark and wood is removed about once a week to stimulate a new flow of gum.

The gum of these Georgia pines is entering into the making of many useful products. The chief consumers of turpentine are makers of adhesives and plastics, automobiles and wagons, chemicals, pharmaceuticals, foundries and foundry supplies, furniture, insecticides, disinfectants, linoleum and floor covering, oils and greases, paint, varnish, lacquer, printing ink, railroads and ship yards, rubber, shoe polish, shoe materials, soap, and other less important industries.

Rosin is used chiefly by abattoirs, in adhesives and plastics, asphaltic products, automobiles and wagons, chemicals and pharmaceuticals, ester gum and synthetic resins, foundry products, insecticides and disinfectants, linoleum and floor covering, matches, oils and greases, paint, varnish and lacquer, paper and paper size, printing ink, rubber, shoe polish and shoe materials, soap and other industries.

Wood Distillation. Another source of turpentine is from wood distillation. Riding through South Georgia one may see a large tractor with a great beam or crane busy in fields or cutover pine lands. Like some long-necked, prehistoric creature pecking at something in the ground, the outfit moves from place to place. The crane drops to the ground, its steel jaws fasten deeply into a stump, there is a whir and a sudden exhaust of smoke from the tractor, and up comes a pine stump, roots and all. A quick shake removes the clinging earth. As the steel jaws are released, the stump is tossed aside. The monster moves on and in two minutes or less time has siezed upon and removed another stump from the ground.

Trucks haul the stumps to railroad cars where they are loaded and carried to a large plant at Brunswick. The stumps contain a gum that is stored as heartwood in trees and known in South Georgia as "lightwood." At the Brunswick plant the stumps are fed into a chipping machine called a "hog." The chips are steamed and chemically treated to produce turpentine and other products.

The three kinds of wood distillation carried on by Georgia plants are classed as steam distillation of wood, sulphate wood treatment, and destructive distillation of wood. By these methods 151,723 barrels of turepntine of 50 gallons each were produced from April 1 to March 31, 1936-37, and during that period, by the steam distillation process, 724,028 barrels of rosin of 500 pounds each were produced.

Until recently the naval stores industry has depended largely upon chemists of other industries to find new uses for naval stores; but now the naval stores interests have established a research laboratory at Savannah to engage in the undertaking.

CHAPTER X

WOOD FOR PAPER AND CELLULOSE PRODUCTS

With all the forest land in the southern states, the long growing season, abundant rainfall and rapidly growing trees of high value, no other section of the country offers as great opportunities for sustained commercial forestry. An appreciation of these facts is leading the paper industry to establish its mills in the South. Already the greater part of the country's kraft paper manufacture is in the southern states. White newsprint paper and excellent book and bond paper have been successfully made from southern pines by the Herty Foundation Laboratory at Savannah.

For many years the belief that southern pines contained too much oleoresin to make them useful in the manufacture of white paper went unchallenged until Dr. Charles H. Herty, native Georgian and noted chemist, declared that as the result of chemical analyses, the gum content of southern pines is comparable to red spruce from which white paper is largely made. Soon thereafter studies made by chemists of the Forests Products Laboratory at Madison, Wisconsin, provided an explanation of why slash and longleaf pine produce so much gum or oleoresin, and have so little present in their wood. The heavy exudation of gum of these trees was found to be made by cells that functioned only when the tree is wounded and then only for the purpose of covering the wound with gum. Dr. Herty's position was sustained. Southern pines are not full of gum; in fact, they do not contain enough to prevent their use in the manufacture of newsprint, book, and bond paper.

How to handle pine fiber to get the very best products at lowest possible cost has been the basis of continued study at the Herty Foundation Laboratory.

All species of pines in the South have been proved by Dr. Herty to be suited to white paper manufacture, and his work with black gum and tupelo gum has revealed the practicability of drawing on the large supply of material these trees afford for making white paper. Paper used for printing newspapers in Georgia is imported from Europe, with the cost increasing. Southern forests can be drawn upon to produce enough newsprint to supply the needs of the whole country.

A paper mill represents millions of dollars of investment which the owners are slow to scrap. It was only when initial kraft paper mills were set up in the South and revealed the advantages by the

competition they created that kraft mills came in numbers to this region. The same will occur, it is thought, when mills for white paper manufacture get started in the South.

Paper mills located at Savannah and Brunswick, Georgia, and at Fernandina, Port St. Joseph and Panama City, Florida, draw on forests of South Georgia for pulpwood, while North Carolina mills draw on mountain regions of Georgia. The area between the mountains and coastal plains known as the Piedmont Plateau is too far from existing paper mills to profitably market pulpwood because of the high freight cost.

Some paper mills specify bolts 5 feet long which are accepted in "units" or "long cords." The difference between a "long cord" and a standard cord is that the sticks or bolts are 5 feet rather than 4 feet long. Quite generally the mills consider "pens" as units. A pen is made * feet high, built up like a log cabin with four sides.

It is quite a common practice for paper mills to have contractors to buy pulpwood on a stumpage basis, that is as standing timber. These contractors engage a crew of men to get out the timber and deliver it to a railroad siding.

DANGER CONFRONTED. Paper mills can use smaller timber than sawmills and buyers of poles, crossties, and other forest products. They can also utilize smaller timber than the turpentine operator, cutting bolts as small as 4 inches in diameter.

A landowner whose timber is 6 to 8 inches in diameter has means of deriving revenue only from paper mills. The young timber which he thought had no value, the pulpwood contractor now wants to buy, and if sold on a stumpage basis with no restrictions, the young timber is all removed or clean cut. This done, the sawmills, turpentine operators, and buyers of poles, crossties and other forest products are deprived of a source of materials that would have been created by the forest had it not been clean cut.

If clean cutting is widely practiced it will mean the destruction of many existing woodworking industries. But paper mills, sawmills, turpentine operators and all other users of the forests, can be supplied by Georgia's forests if the timberland owners can be led to follow a practice of so handling their forests as to provide materials for all forest industries; and by so doing they can receive the largest returns from their timberlands.

A statement of what to cut and what not to cut for pulpwood, prepared by the U. S. Forest Service for Georgia conditions, is as follows:

TREES TO CUT FOR PULPWOOD: (1) Worked out naval stores trees; (2) crooked and poorly formed trees; (3) weaker crowned trees in dense stands and "wolf trees" overtopping young trees; (4) overmature, red heart trees; (5) fire scarred, insect damaged, or diseased trees.

TREES TO LEAVE IN CUTTINC PULPWOOD: (1) Round longleaf and slash pines (not turpentined); (2) straight and best formed trees; (3) trees with good, thrifty crowns; (4) young, thrifty, fast growing trees. (5) healthy trees free from injury.

PAPER MANUFACTURING. The main product of paper mills in the South is kraft paper. The word "kraft" is a German word meaning "strength." This type of paper is usually brown and is extensively used for wrapping purposes and for bags.

Pulpwood cutting. Note that thinnings of the forest provide the pulpwood stacked in pens and that a number of trees are left for a future crop—a good forestry practice.

Upon arriving at the paper mills the pine bolts have their bark removed by machines. The wood is then chipped into small fragments by powerful machines called "hogs." The chips are digested in chemicals that separate the cellulose from the lignin of the wood, following which the cellulose is washed to remove all foreign matter, and is then a pulpy material which is pressed between drums or rollers and issues as paper.

White paper is made somewhat in the same way but the material is treated with bleaching chemicals. Newsprint paper is made up of a large amount of ground wood, that is, wood mechanically ground into a powdery form. Ground wood and fiber pulp obtained from chipped wood are combined to make newsprint. Newsprint does not require the strength needed in kraft paper.

A number of plants are making rayon in the South but only one, located at Fernandina, Florida, is now being constructed to make rayon from southern pines. One plant located at Brunswick is now making white paper from southern pines.

An interesting use of chestnut trees killed with blight is that the wood is distilled for the production of tannic acid used largely in leather manufacture, while the residue of wood fiber, too short to make paper, is used to make paperboard used for paper cartons and other commodities.

CELLULOSE PRODUCTS. Cellulose gets its name from the fact that it is derived from cells. Cotton lint is almost pure cellulose, and wood cells are likewise high in cellulose content. Wood appears destined to be the main source of cellulose because more cellulose per acre can be obtained from wood than from any other material.

Heretofore most of the cellulose used in many different commodities has been derived from red spruce, also the main source of white paper, but due to Dr. Herty's tests, the fact is now well-known that the southern pines are as well-adapted to the purpose as the spruce.

The process by which cellulose is made is like that of papermaking until the raw pulp is produced, then it is broken down by chemical processes into a liquid form before entering into its final product.

A noted chemist has said that the world is entering the cellulose age. Since trees are the largest and cheapest source of cellulose, the prospects are that timberland owners will share in the benefits. Rayon, a cellulose product, can be made from southern pines, a fact fully demonstrated by Dr. Herty. The transparent wrapping paper known commonly as "cellophane" is a cellulose product made from wood. Cellulose goes into shatterproof glass of automobiles. It is

an important part of artificial leather now extensively used. Nitrocellulose, a high explosive, has been rendered harmless, and useful as a quick drying paint. Photographic films and moving picture films, lacquers, drinking straws, and numerous other articles are now made from cellulose. Perhaps before long chemists will have mankind eating wood, transformed into palatable starchy material —a better cellulose product than Germans were forced to eat during the World War.

CHAPTER XI

FORESTS AND WATER

The forest that covered Georgia before the white settlers cleared their farm lands caught rainfall with its spongelike carpet, so that comparatively little surface water made its way into streams. The rain water that was not used by trees and other vegetative growth seeped into the ground to emerge as crystal clear water of springs.

In former days all the streams were clear and heavily stocked with a variety of fish. Today streams run red with clay and are rarely clear. The few fish remaining are generally the poorer sort, with the game fish like the trout and bass long since driven out by a change of environment they could not endure.

As the tide of white men continued to flow into Georgia, still more and more land was cleared of its forest growth. Soils on rolling lands and even steep slopes were cultivated because they were fertile and produced large crops.

Cotton and corn soon became the leading crops. Both were cultivated with considerable space between the plants. Rain falling on these lands found plenty of opportunity to flow between the stalks of cotton and corn and to carry along loose soil to the streams. Year after year the fertile topsoil thus slipped away until the subsoil was reached.

Many acres became too poor to grow cotton and corn profitably and were abandoned. Nature undertook to reclaim what man had despoiled, and in time neighboring pines released their seeds on the winds. Within a few years, pine seedlings were growing in the eroded and gullied fields. Young pine roots clutched the soil, checked erosion, and began the slow process of improving the soil. Streams formerly heavily charged with sediment became clearer.

Many acres abandoned for agricultural crops in Georgia are still eroding badly. In many instances the pines are struggling to reforest

the old eroding fields but are hindered year by year by fires that burn through the sedge grass and destroy their seedlings.

Some eroded fields are not flanked with seed bearing pines, or at least there are not enough of them to carry on natural reproduction, hence the necessity for planting seedlings artificially.

It is generally admitted that trees control soil erosion better than any other means, natural or artificial. But of course in some areas, if all sloping land were given over to trees, there would not be enough left for the farmer to grow his crops and establish pastures. Erodible lands that are to grow crops and those that are to grow trees, constitute a problem for the farmer to solve under the guidance of agricultural agencies of the state and Federal governments.

Forests, land terracing, rotation of wide spaced cultivated plants with close growing crops, establishment of permanent pastures and stabilizing channels for removing the rainfall from sloping lands—all are needed for checking soil erosion and for flood control.

It has been shown that unburned forests absorb rainfall in large quantities. Therefore the greater the forested area on a watershed the less danger from floods. The greater the area of land abandoned for agricultural crops, the greater will be the number of gullies to collect and quickly carry water to streams, hence the greater will be the floods on the watershed. If all such land were reforested, the flood danger would be minimized.

Gully floods are the most dangerous because of the amount of materials carried and because the gullies move water suddenly into the streams. Often two-thirds of the fluid material is composed of solids, such as silt, sand, gravel, and even stones. The greater the amount of water the swifter it flows. According to a law of physics, if the velocity of a stream is increased ten times, its transporting power is increased one million times. It has been determined that a current having a velocity of two miles an hour will move stones the size of a hen's egg. If the velocity of the stream were twenty miles an hour, a boulder weighing one hundred tons would be moved.

Carrying stones, gravel, and sand, the abrasive power of the stream flow is able to gash stream banks, scour away bottom lands with overflow water, and by its strong impact, sweep away bridges, mills, and houses.

The value of the plant food material permanently lost to Georgia in any one year would go far toward meeting the cost of planting trees on all the abandoned eroding lands of the state, and instead of such lands being a source of floods and damage to other lands, they could be growing trees to add to the forest wealth of the state.

CHAPTER XII

FORESTRY EDUCATION IN GEORGIA

The first institution to give degrees in forestry in the South was the University of Georgia. The George Foster Peabody School of Forestry was established in 1906 and has sent out many graduates who are now employed by the states and Federal governments.

Georgia was also the first state to establish a course in forestry in high schools having vocational agriculture teachers. This course was established in 1928. It was thought that while teaching future farmers how to grow and market farm crops and livestock as a means of earning a living that a knowledge of how to handle a farm forest should also be helpful. The chief end sought by the undertaking was to equip the student with fundamental knowledge of how to protect and develop forest resources.

SCHOOL FORESTS. For practicing forestry jobs, vocational agriculture teachers were encouraged to establish school forests of ten acres or more. No trouble was experienced in obtaining the required forest land. In most communities the school forests were leased for ten or more years by local school boards. The school forests were surveyed and mapped by technical foresters who also made management plans to be followed for converting them into ideal demonstration forests. The only printed material dealing with the practice of forestry used in these schools has been free bulletins prepared by the state Division of Forestry and the U. S. Forest Service. These serve as sources of information and guidance in teaching forestry jobs. The Division of Vocational Education has organized this information into teaching material. Technical guidance has been given by representatives of the state Division of Forestry who, when visiting the schools, have conducted demonstrations showing the technique of doing forestry work. As an incentive to student interest, the state Division of Forestry has financed and conducted a forestry camp each summer, with each school eligible to one free camp scholarship.

The Georgia Forestry Association, an organization of citizens devoted to promoting forestry, has shown its interest and given encouragement to the undertaking by contributing cash prizes to teachers and students doing outstanding work in forestry. These are called "Herty Prizes" in honor of Dr. Charles H. Herty.

RESULTS. During the ten years the project has been in operation, between 40,000 and 50,000 rural boys of Georgia have received

practical training in forestry. About 70 per cent of these young men are now engaged in farming and are applying the knowledge obtained to the forest areas under their control. While in school these young men were responsible for the planting of millions of pine tree seedlings and for the construction of thousands of miles of firebreaks to prevent the spread of forest fires. In many instances these young men have played an important role in changing the attitudes of their communities regarding forests. They have been responsible for the general adoption of many improved forest practices in their respective communities. Some have graduated from the School of Forestry at the University of Georgia and have become trained foresters. A number have become vocational agriculture teachers and are carrying their knowledge of forestry to future farmers.

FORESTRY AS A CAREER. In recent years interest in forestry has grown and the demand for foresters has increased. As a result the schools of forestry throughout the county have greatly increased their enrollments. It is difficult to predict whether the profession of forestry is to be over supplied or under supplied with trained men.

Foresters do not have an opportunity in practicing their profession to become wealthy, but most foresters would rather be engaged in their interesting work than to be wealthy. For any who would rather be a forester than anything else the field is open.

Aside from the School of Forestry at the University of Georgia, other southern universities offering degrees in the subject are Louisiana State University, Baton Rouge, the State College of Agriculture at Raleigh, North Carolina, and the University of Florida. Duke University, Durham, North Carolina, offers advanced degrees in the subject. Other institutions in the South have forestry in their curricula.

LAND CLASSIFICATION DATA—BY COUNTIES

The following data, compiled by the Georgia Forest Service in 1926 to show the potential forest land of Georgia, have probably changed so little that they can now be reprinted as a fair approximation of the forest and potential forest land of the state.

County	Total Area of County	Potential Forest Land	Percent Forest Land
Appling	290,560	231,800	80
Atkinson	211,200	172,550	82
Bacon	173,440	137,437	79
Baker	228,480	140,985	62
Baldwin	196,480	109,508	56
Banks	142,080	79,211	56
Barrow	107,520	46,085	42
Bartow	301,440	174,148	58
Ben Hill	163,840	103,213	63

County	Total Area of County	Potential Forest Land	Percent Forest Land
Berrien	320,000	246,343	77
Bibb	177,280	97,215	55
Bleckley	131,200	60,961	46
Brantley	280,537	190,184	67
Brooks	328,960	182,924	56
Bryan	275,840	244,058	88
Bulloch	427,520	263,411	63
Burke	611,840	330,471	54
Butts	129,920	72,301	56
Calhoun	181,760	95,312	53
Camden	455,040	441,893	97
Candler	145,920	78,665	54
Carroll	314,880	147,289	47
Catoosa	108,160	58,781	54
Charlton	563,840	542,744	91
Chatham	236,800	198,109	84
Chattahoochee	139,520	113,983	81
Chatooga	209,920	115,335	55
Cherokee	274,560	189,628	69
Clark	72,960	24,917	34
Clay	129,920	53,956	42
Clayton	90,880	36,865	40
Clinch	576,000	546,708	95
Cobb	225,920	111,738	49
Coffee	404,480	290,694	72
Colquitt	338,560	188,056	56
Columbia	224,000	141,505	63
Cook	154,240	102,250	66
Coweta	283,520	143,701	51
Crawford	204,160	132,991	65
Crisp	177,280	76,718	43
Dade	119,040	96,005	81
Dawson	138,240	107,529	74
Decatur	526,720	343,173	65
DeKalb	174,080	94,147	54
Dodge	275,840	109,665	71
Dooly	254,080	112,805	44
Dougherty	218,880	122,456	56
Douglas	133,120	81,366	61
Early	335,360	180,090	54
Echols	231,680	212,417	92
Effingham	286,720	239,534	84
Elbert	231,040	123,546	53
Emanuel	488,960	318,139	65
Evans	183,680	143,540	78
Fannin	256,640	217,526	85
Fayette	149,760	83,415	56
Floyd	321,280	182,092	57
Forsyth	158,080	83,613	53
Franklin	178,560	86,197	48
Fulton	346,240	160,992	46

County	Total Area of County	Potential Forest Land	Percent Forest Land
Gilmer	281,600	241,544	86
Glascock	108,800	73,141	67
Glynn	280,960	267,611	95
Gordon	240,000	134,401	56
Grady	284,160	168,482	59
Greene	266,240	152,120	57
Gwinnett	281,600	144,491	51
Habersham	185,600	144,479	78
Hall	279,680	179,466	64
Hancock	339,200	214,165	63
Haralson	181,760	113,255	62
Harris	320,640	217,188	68
Hart	167,040	75,465	45
Heard	182,400	102,863	56
Henry	207,360	91,625	44
Houston	374,400	210,098	56
Irwin	241,920	149,576	62
Jackson	227,200	99,477	44
Jasper	205,440	96,408	46
Jeff Davis	192,000	150,443	78
Jefferson	413,440	268,281	65
Jenkins	218,880	132,615	61
Johnson	186,880	94,590	51
Jones	241,280	139,858	58
Lamar	118,782	33,625	28
Lanier	123,428	56,259	45
Laurens	515,840	258,477	50
Lee	208,640	95,539	46
Liberty	599,040	541,111	90
Lincoln	186,240	128,209	69
Long	244,598	147,249	60
Lowndes	304,640	192,391	63
Lumpkin	179,200	150,396	84
McDuffie	183,680	118,815	65
McIntosh	300,800	289,687	96
Macon	236,160	102,162	43
Madison	181,760	85,291	47
Marion	230,400	147,342	64
Merriwether	317,440	166,359	52
Miller	161,920	89,001	55
Mitchell	350,720	174,048	50
Monroe	373,760	242,309	65
Montgomery	121,600	60,435	50
Morgan	249,600	128,170	51
Murray	218,880	160,145	73
Muscogee	150,400	101,360	67
Newton	167,680	65,886	39
Oconee	110,080	42,259	38
Oglethorpe	322,560	196,637	61
Paulding	207,360	128,447	62
Peach	95,651	12,340	12

County	Total Area of County	Potential Forest Land	Percent Forest Land
Pickens	147,840	110,114	74
Pierce	330,880	276,566	83
Pike	196,480	80,906	41
Polk	202,880	118,160	58
Pulaski	165,120	83,356	50
Putnam	231,040	135,086	58
Quitman	92,160	51,234	56
Rabun	241,280	219,354	91
Randolph	263,680	142,443	54
Richmond	204,160	118,161	58
Rockdale	76,160	30,122	40
Schley	98,560	48,673	49
Screven	508,160	353,551	70
Seminole	160,214	54,833	34
Spalding	133,760	51,105	38
Stephenson	106,240	69,918	66
Stewart	263,040	153,878	58
Sumter	291,840	111,553	38
Talbot	199,680	125,022	63
Taliaferro	135,680	87,536	65
Tattnall	298,240	221,013	74
Taylor	217,600	130,633	60
Telfair	238,720	149,278	63
Terrell	206,080	82,652	41
Thomas	339,200	209,570	62
Tift	155,520	82,474	53
Toombs	251,520	178,620	71
Towns	115,840	91,932	79
Truetlen	167,680	113,073	67
Troup	278,400	149,425	54
Turner	147,840	71,052	48
Twiggs	200,960	118,170	54
Union	207,360	169,565	82
Upson	202,880	124,263	61
Walker	276,480	164,876	60
Walton	211,840	87,475	41
Ware	493,440	452,066	92
Warren	258,560	183,483	71
Washington	428,160	226,532	53
Wayne	504,320	446,524	88
Webster	193,280	132,329	69
Wheeler	168,960	100,674	60
White	156,800	127,798	82
Whitfield	181,120	99,982	55
Wilcox	257,920	139,525	54
Wilkes	293,120	150,493	51
Wilkinson	302,080	206,776	68
Worth	416,540	245,145	59
	37,583,900	23,970,960	63.75

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MINERAL RESOURCES OF GEORGIA

Prepared by

Division of Mines, Mining and Geology

OF THE

Department of Natural Resources

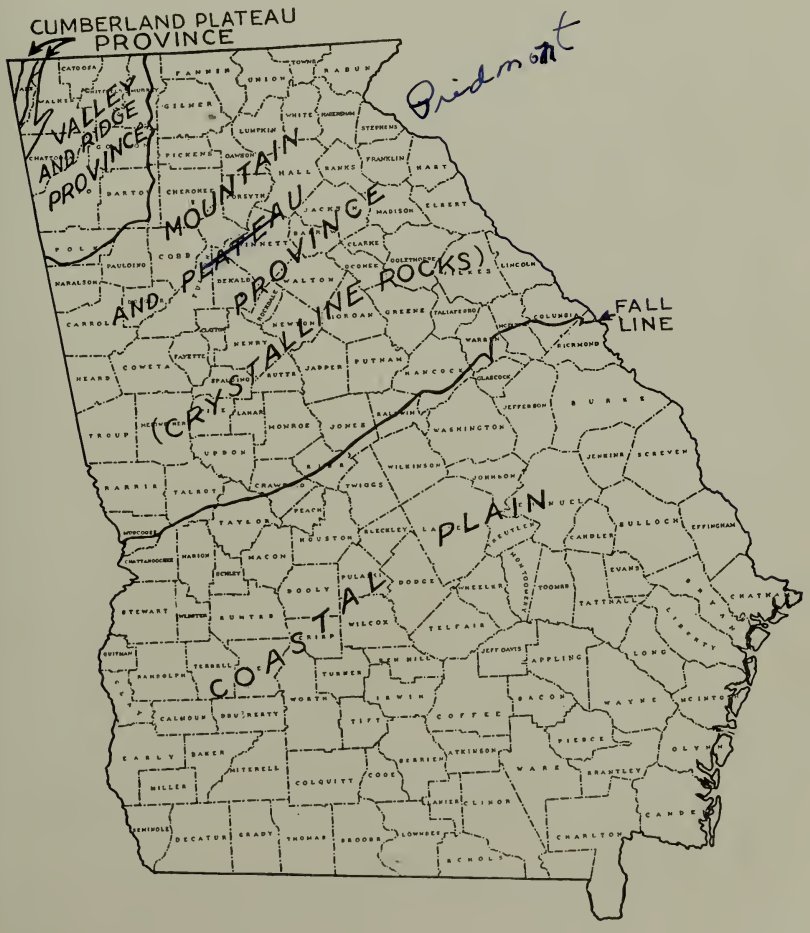
Mineral Resources Of Georgia

SPECIAL TABLE OF CONTENTS

Mineral Resources of Georgia

INTRODUCTION

The outline map of Georgia illustrates the important geologic divisions of the state. It shows the position of the great central belt of crystalline rocks; the Coastal Plain area of east and south Georgia separated from this crystalline belt on the east by the Fall Line which passes approximately through Augusta, Macon, and Columbus; northwest Georgia comprising the Valley and Ridge Province, sometimes known as the Great Valley Province; and extreme northwest Georgia where a small area of the Cumberland Plateau is found.



The great central belt of crystalline rocks are the oldest rocks in the state. Most of these rocks go back to the very beginning of geological history. Since they represent rocks formed in earliest times they are said to be of Pre-Cambrian age. Our first abundant records of life occur in very ancient sedimentary rocks which belong to the Cambrian period of geological history.

Very many different types of rocks and minerals are found in the Crystalline Belt. The rocks for the most part are granites, gneisses, schists and slates. Granites were once molten lava. They represent lava which moved up from the interior of the earth and which hardened before it reached the surface of the earth. Cooling slowly in large masses below the surface, this lava had a long time for crystallization. Consequently, it is composed of coarse grained materials, particularly feldspar, quartz, and mica. Gneisses and schists represent rocks which have been mashed below the earth's surface, subjected to high temperatures, and recrystallized in such a manner as to produce banding of minerals. When these banded rocks contain much feldspar they are generally massive, and are called gneisses. Where they contain a great deal of hornblende or mica they are generally called schists. The slates are very finely crystallized rocks with unusually good cleavage.

You will find when you read the pages which follow that the ancient Crystalline Belt of Georgia contains an astounding variety of rocks and minerals. A very large number of our mineral deposits, such as asbestos, chlorite, chromite, copper, corundum, feldspar, gold, granites, graphite, marbles, mica, precious stones, pyrite, sericite, serpentine, talc, and others, come from this belt.

If we go back to the earliest times in the history of the building up of Georgia, we find back in Pre-Cambrian times that this great Crystalline Belt contained high mountains. Out of these mountains streams flowed to the west. In the beginning of Paleozoic times these westward flowing streams emptied into the ocean which at that time covered a great area of the continent west of middle Georgia. Throughout the periods of the Paleozoic era from Cambrian to Carboniferous times, streams continued to deposit their sediments in this great salty sea. A vast thickness of sandstones, shales, and limestones was laid down. These are the rocks which we may find today in the Great Valley and Cumberland sections of northwest Georgia. The limestones frequently contain many fossils. The types of fossils are marine shells.

The Appalachian Valley and Ridge Province contains very many valuable mineral resources, particularly barite, bauxite, cements,

clays, flourospar, iron ores, limestones, manganese, ocher, road materials, sand and gravel, slate, tripoli, and others. Our coal is found in the Cumberland Plateau section.

At the close of the Paleozoic era or the end of Carboniferous times, the crust of the earth was mashed by great forces coming from the east. These forces crushed the rocks together. They folded the sedimentary beds of rock in the Appalachian Valley and Ridge section into great anticlines and synclines. Anticlines are upfolds of rock and synclines are downfolds of rock.

Following the close of this great period of folding, the rocks of the Appalachian Valley and Ridge Province, the Cumberland Plateau and the Crystalline Belt were worn down by streams for millions of years. Stream systems developed which moved southeast and emptied into the Atlantic. By the beginning of Mesozoic times rivers were carrying vast quantities of sand and silt down to the Atlantic Ocean and depositing them near what we now call the Fall Line. This marks the beginning of the formation of the Coastal Plain of Georgia. Throughout the Mesozoic times, the Tertiary times and to the present, the Atlantic Ocean has gradually and slowly receded eastward. The rivers have moved down from a line approximately passing through Augusta, Macon and Columbus to empty into the sea at the present shore line. As the sea receded the Coastal Plain rose above water level.

The rocks of the Coastal Plain are of Mesozoic, Teritary, and Recent ages. The oldest rocks, that is, those formed first, are found up near the Fall Line. As we go southeastward, we come to younger and younger layers, until we come to the sands and silts which are being laid down today on the shore line. Many valuable mineral resources are found in the sedimentary rocks of the Coastal Plain. These rocks are composed of sands, marls, limestones, clays, fuller's earth, and other types.

CHAPTER I

Importance of Georgia's Mineral Resources

Georgia, the largest state east of the Mississippi River, with rock formations ranging in age from the most ancient to the youngest and extending from the Appalachian Mountain to the Atlantic Ocean, is endowed with mineral resources in great variety and in almost unlimited quantity. Some idea of the present importance and future possibilities of this branch of Georgia's natural resources may be gained from the fact that more than 35 different rocks, minerals

and metals are either being mined or have commercial possibilities in the near future.

The following are some of the more important commercial minerals: barite, cement and cement materials, clay and clay products, fuller's earth, gold, granite, kyanite, limestone, marble, mica and micaceous minerals, ocher, sand and gravel, talc and soapstone. The following more or less rare and interesting minerals are found in Georgia: agate, amethyst, beryl, calcite, corundum (ruby and sapphire), epidote, hyalite, lazulite, moonstone, opal, rutile, staurolite. Hyalite and certain varieties of calcite, corundum and opal are fluorescent.

The total value for the mineral output for Georgia for the year 1936, the last year for which figures are available, was $12,750,000, an increase of five and one-quarter million dollars over the low depression year, 1933, but approximately five million dollars less than for the year 1929.

Actually any discussion of Georgia's mineral resources might more properly be referred to as a discussion of Georgia's undeveloped mineral resources, since comparatively little progress has been made toward their development and exploitation. Instances in great number might be cited in substantiation of this statement.

Gold has been mined in Georgia for over one hundred years with an estimated total production of over twenty million dollars. Almost all of this gold has been taken from the stream gravels and oxidized ores near the surface of the ground where it was easy to mine. This early mining reached such proportions that it justified the establishment of a local branch of the United States Government Mint in Dahlonega exactly 100 years ago this year, 1938. During all these years no systematic, persistent effort has been made to determine the existence of commercial deposits of gold ore at depth. Only within the past few months one of the really big mining and smelting companies began such an investigation in Georgia.

For many years Georgia's extensive deposits of pure white clay have been her most valuable mineral resource. From these deposits Georgia has shipped over one-half of the white clay mined and consumed in the United States. Although Georgia kaolin has long been used in the manufacture of china and white ware, it was not until the present year that a plant of this type was established in the state.

The possible existence of petroleum deposits in Georgia has long been recognized. Further, it is known that there are formations in our Coastal Plain which are quite similar to the formations in the oil and gas producing areas of Louisiana and Texas. Although spas-

modic, ineffectual efforts have been made to prospect for petroleum, the first real attempt by a company with adequate financial backing was inaugurated on April 2, 1938, the date on which an important company started drilling its first well at Offerman, in Pierce County.

Investigations by the technical staff of the Division of Mines, Mining and Geology have revealed the existence in Georgia of practically unlimited deposits of raw materials suitable for the manufacture of rock wool and glass. Considerable quantities of these materials are now being shipped to adjoining states. Our studies clearly demonstrate the feasibility of establishing such manufacturing plants within the state of Georgia.

At the present time paper pulp is being manufactured in Georgia and shipped to the eastern seaboard for fabrication into paper. At the same time, Georgia kaolin is shipped out of Georgia to be used as a filler and surfacing agent for paper. The market price of this paper pulp is only 1½ cents per pound, while the average market price for paper made from this pulp is understood to be 8 cents per pound. It would not only be feasible but would result in a greater net revenue to the state of Georgia if this pulp were manufactured into paper within the limits of the state of Georgia, at the same time using Georgia kaolin as a filler and surfacing agent, rather than to ship both the paper pulp and the kaolin out of the state for processing and utilization.

Enormous tonnages of bauxite are known to exist in Georgia. However, only a relatively small proportion of this total tonnage contains sufficiently high percentage of aluminum oxide to enable it to compete with ordinary high grade bauxite in other states. It is believed, however, that this material by simple treatment methods can be beneficiated to the extent where it will be able to compete with the higher grades of bauxite from any locality. In a like manner there are practically unlimited quantities of barite that need only slight bleaching or other treatment to convert them into extremely high grade barite.

Apparently the dominant factor in the hindred progress of the development and exploitation of Georgia's mineral resources has been her preoccupation with agriculture. Georgians generally have remained uninformed concerning the existence and value of the many minerals of their state, and untrained in the art of producing and utilizing them, with the result that many landowners have lived a lifetime unmindful of the fact that their soil contained mineral wealth equal to if not greater than that obtainable from agriculture.

CHAPTER II

Artesian Water

Artesian waters of Georgia are mainly confined to the Coast Plain section. A considerable number of deep and flowing wells are also found in the Crystalline and Paleozoic areas, but as a general rule these wells furnish only a limited amount of water. Perhaps all of the wells drilled in the Coastal Plain of Georgia may be classified as artesian, when the definition of that term is understood to mean that the static level of water in the well is higher than the bed from which it flows. It is not necessary, by this definition, that a well must flow at the surface to be classed as artesian.

There are two main areas of flowing wells in the Coastal Plain: one, the largest, parallels the Atlantic coast and extends inland roughly 30 to 40 miles; the other lies in portions of Crisp, Lee, Dougherty, Calhoun, Baker, and Mitchell counties. Stream gravels along the major rivers also afford areas of flowing wells.

Geology. Conditions for the formation of artesian wells are as follows: (1) a permeable aquifer, which is a porous water-bearing bed; (2) must be confined above and below by nonporous or impervious beds; (3) these beds must dip so that the outcrop, at which the water enters the permeable bed, will be higher than the mouth of the well; (4) the outcrop of this bed must be sufficiently broad to insure an adequate supply of water. Under these conditions, water may migrate great distances underground.

The geologic structure of the Coastal Plain of Georgia fills the above conditions very closely. All beds have a gentle dip from the Fall Line toward the ocean. Older formations outcrop close to the Fall Line while those that are younger outcrop in bands approximately parallel to the Fall Line, and all at successively greater distances from it.

Many of these beds are porous: some are limestone, some are sands, others may be gravels; consequently they are excellent conductors of water. In addition, many of the porous beds are bounded by impervious shales which greatly resist the passage of water. Therefore, we should expect some of the more favored beds to be aquifer and consequently to find areas of artesian water at some distance from the Fall Line and at various depths.

The sands and gravels of the Cretaceous, the limestones of the Eocene and those of the Miocene, all act as aquifers. The water-bearing beds become thicker to the southeast, thus containing more

water. The most prolific source of artesian water supply in south Georgia are the Eocene limestones. The Flint River limestone also is a source of water supply for a large number of wells. These two limestones are responsible for the flowing wells along the Atlantic seaboard. The sands and gravels of the Cretaceous supply the area of flowing wells to the west of Flint River in the vicinity of Albany. Artesian but not flowing water occurs in practically all portions of the Coastal Plain.

HISTORY. The first satisfactory artesian well sunk in Georgia was drilled 16 miles west of Albany on the Fort plantation in Daugherty County in 1881. It was completed at a depth of 550 feet, thus demonstrating the practicability of obtaining artesian water in south Georgia. Four years after the initial well, a successful deep well was drilled at Savannah. These two wells greatly stimulated drilling throughout the entire region so that in a short time a majority of the large towns had deep wells. Almost every community has now bored at least one deep well to obtain water supply for public purposes, and drilling is progressing steadily.

KIND OF WATER. The most common solids found in artesian water of south Georgia are the various carbonates, sulphides, chlorides, and the alkalies and alkaline earths, together with silica, alumina, and iron; while the gases most commonly found are hydrogen sulphide and carbon dioxide. The mineral constituents average about 130 parts per million. The total amount of these constituents and the ratio they bear to each other depend largely upon the character of the water-bearing strata. Thus water from highly calcareous rock, such as limestone, will carry a larger percentage of mineral material than will water from sand. In the first case, the chief mineral constituent is calcium carbonate, and in the second, silica. Furthermore, the water from the limestone horizon will be classed as "hard"; while that from sand is generally "soft." With this knowledge it should be expected that the artesian water along the Atlantic Coast should be hard, because it comes from limestone. Conversely, the water west of Flint River, around Albany, should be soft, because it is obtained from a sandstone bed.

USE. The artesian waters of south Georgia have a variety of uses, chief among which are those for sanitary and drinking purposes. In some counties such water has been used for irrigation, and today, a new use is coming into being because of the large wood pulp mills being constructed throughout the region. In one or two instances extremely large flows have been utilized for power purposes. The

health benefits derived from general use of artesian waters in the Coastal Plain cannot be overestimated.

Uncontrolled flows, with consequent wastage of artesian water, should be avoided at all cost because our underground water supply is by far the most valuable resource which the state possesses.

ASBESTOS

Asbestos is a fibrous silicate mineral. The fiber is long or short, flexible, and easily separated by the fingers into soft threads. Most of Georgia's asbestos belongs to the long fiber type. It is generally white, cream or gray but sometimes greenish in color.

LOCATION. Asbestos is found in many localities in the Crystalline Belt of Georgia. It has been mined in the past in White, Habersham, and Rabun counties. Here the deposits belong to a type known as mass-fiber asbestos. At one time Georgia was the largest asbestos producing state in the Union. Sall Mountain, White County, Georgia, is a famous locality for long-fibered asbestos.

GEOLOGY. Asbestos occurs in both the Blue Ridge and Piedmont regions of Georgia. The geology of asbestos is very similar to the geology of talc and soapstone. The short-fibered, woodlike type is found in narrow veins. In the case of the latter type the fibers may be a foot or more in length but are generally brittle and not of the best quality. For the most part, asbestos comes from the alteration of igneous rocks.

MINING AND USES. The better varieties of asbestos are spun and woven into fireproof cloth. It is an excellent nonconductor of electricity, and thus is used in electric insulation, heat insulation, and in the manufacture of fireproof paint.

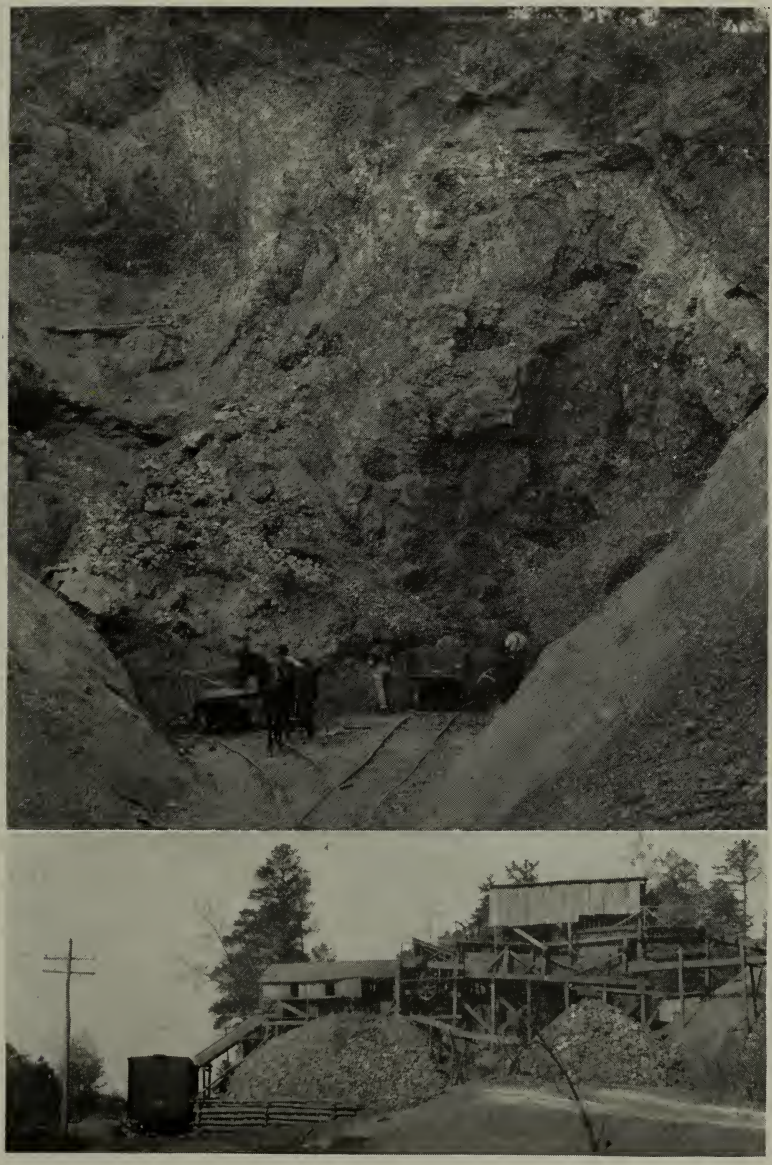
Asbestos resists fire, insulates against heat and sound, resists chemical corrosion, and is light in weight. In spite of many substitutes, its uses are continually increasing. For this reason, Georgia's asbestos may be mined again in the future.

BARITE

Georgia stands second in the United States in the production of barite. Barite, or barytes, sometimes called heavy spar, is a white, heavy mineral; its composition is barium sulphate.

LOCATION. Most of the barite deposits of Georgia occur in northwest Georgia in the folded sedimentary rocks of Paleozoic age. Large

deposits of barite occur in Bartow county in the vicinity of Cartersville. Other deposits occur near the center of a belt about 75 miles long and 25 miles wide, extending from near Ruralvale, 6 miles south of the Tennessee line, to the vicinity of Esom Hill near the Alabama



BARITE—*This mineral is used in paints and other products to give body or base. Above—Excavating barite ore. Below—Barite washing plant.*

line. Floyd, Bartow, Cherokee, Gordon, Murray and Whitfield counties contain most of the state's barite.

GEOLOGY. The important deposits of barite are known as residual deposits. This means that the barite occurs in masses of various sizes in clay where it has been concentrated through the weathering of large quantities of barite-bearing limestones. This limestone is of Paleozoic age. In the Cartersville area, the limestone is known as the Shady dolomite.

MINING AND USES. Barite is mined by the apencut method; that is, it is dug out of the hillside with steam shovels. It is then hauled by trucks to the mill where it is cleaned and concentrated. Most of the barite mined at the present time in Georgia comes from the Cartersville district. The future reserves are large.

Barite is used in the manufacture of paint and barium chemicals, and as a filler in various products. Barite is also employed as a weighting substance in the mud used in the drilling of wells for oil and gas.

BAUXITE

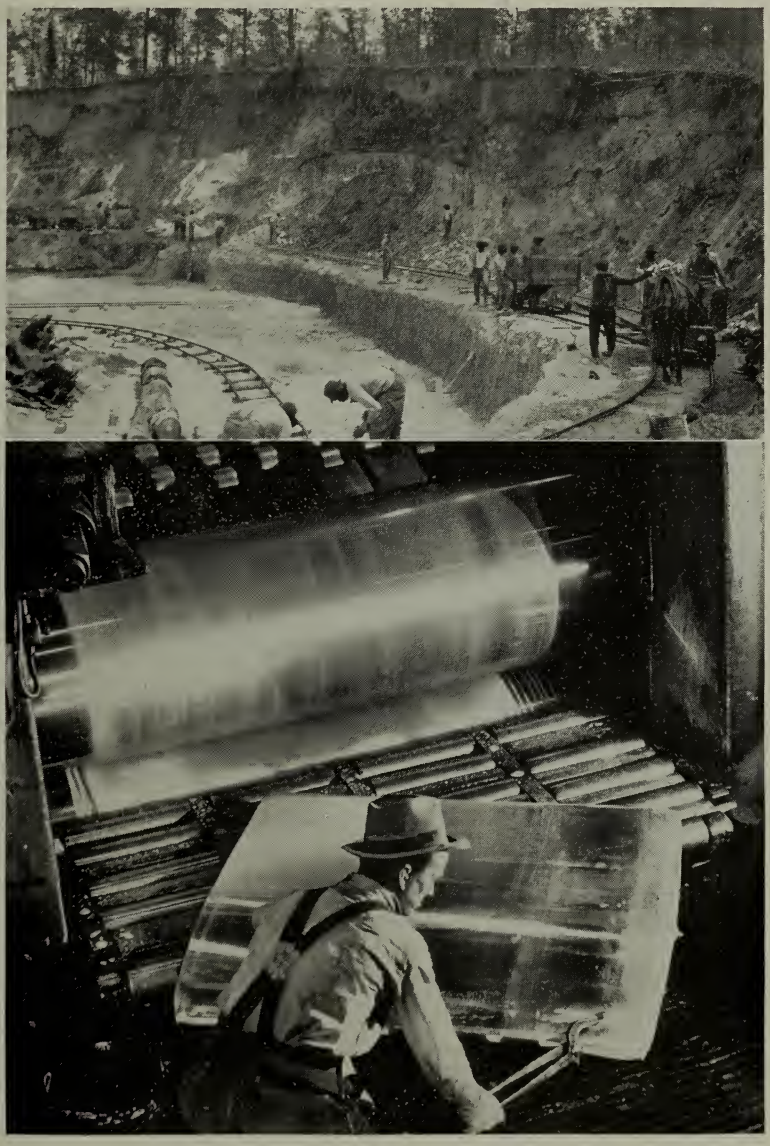
LOCATION. Bauxite, the ore of aluminum, occurs in two distant geological horizons and in two widely separated geographical regions. One of these, now the least important, is situated in Walker, Chattooga, Gordon, Bartow, Polk, and Floyd counties in the northwestern portion of the state. This area is known, geologically, as the Paleozoic region of outcrop.

Bauxite also occurs in an area comprising Sumter, Stewart, Macon, and Schley counties; and in an area of Twiggs, Wilkerson, Baldwin, and Washington counties. The rocks of these counties belong to the Cretaceous and Tertiary systems. Many years ago the deposits of northwest Georgia were practically worked out, so all of the production now comes from the Coastal Plain area.

GEOLOGY. Bauxite deposits of northwest Georgia are found in rocks of Lower Paleozoic age which consist of slates, limestones, shales, sandstone, and conglomerate. These rocks are relatively old and have been subjected to much alteration which has caused them to change form to a considerable extent. In other words, they have undergone some degree of metamorphism.

Most of the bauxite occurs in a rock closely related to limestone known as dolomite. Tremendous earth forces, such as heat and pressure, have produced lines of weakness known as *faults* throughout this entire area. The bauxite deposits are found very closely asso-

ciated with these faults because ground water has dissolved various constituents of the dolomite and deposited them along the faults. In this way the alumina is concentrated.



BAUXITE—*This mineral is used in the manufacture of aluminum. Above—Bauxite mine in Bartow County. Below—Sheets of aluminum manufactured from Georgia bauxite.*

Deposits in south Georgia have probably been formed in quite a different manner, although their past history may have been closely related to the bauxite deposits of northwest Georgia.

The Cretaceous and Tertiary deposits which are relatively young sedimentary rocks, occur as lens-shaped bodies in the earth. Perhaps leaching, which is a solvent action of water, occurs in clays high in alumina, and subsequent precipitation may account for the high concentration in small areas. It may be also that the parent clays of the bauxite deposits in the Coastal Plain were the older kaolin deposits in the Cretaceous system.

HISTORY. The first discovery of bauxite in America was in 1887, at a point a few miles northeast of Rome in Floyd County, Georgia. The mineral had been discovered a few years prior to this in the village of Baux, France.

Upon the recognition of the occurrence of bauxite in the United States, plans were immediately made to mine the material, and in April, 1888, the first mining operations began at the Georgia localities. The first year's output was 728 tons.

Although deposits were later found in Alabama and Arkansas, Georgia maintained her lead in production for several years and is now third in national production.

All of Georgia's production came from northwest Georgia up until 1909 when operations first began in Wilkinson County. In 1907, Otto Veatch, Assistant State Geologist of Georgia, had discovered bauxite in the Coastal Plain of the state and it was these deposits that were opened in 1909. On the whole the deposits of the Coastal Plain were not as rich by volume as those of the Paleozoic area, but they were of considerably greater extent and could be mined as easily.

A few years after the discovery of the Coastal Plain deposits, the northwestern mines were abandoned and today the only mining of bauxite in the state occurs in Sumter and Wilkinson counties.

DESCRIPTION OF THE MINERAL. Bauxite is a hydroxide of aluminum and usually contains some percentage of iron oxide, silica, and titanium oxide. Generally it can be recognized by its unique appearance caused by reddish-brown spherical shaped particles of about the size of a bean or larger scattered through a lighter colored clay. Generally it is fairly soft and claylike in consistency. For economic uses, the mineral should contain more than 50 per cent alumina and also less than 22 per cent of either silica, iron, or titanium oxides.

MININC. Present mining of bauxite is in soft sediments of the Coastal Plain of the state. Usually it is necessary to remove any worthless overburden from the bauxite, which is done either by steam shovels or drag lines. The mineral itself is mined by the same method and is then loaded into trucks and hauled to the nearest railroad for shipment to markets.

Methods of mining in northwest Georgia were necessarily different because of the hardness of the rock containing the deposit. Pits and shafts had to be constructed to reach the pockets of bauxite and hoists or derricks were therefore needed to raise the material to the surface.

Because of its comparative softness, it is possible to dig bauxite by hand labor in some instances and thus cut down the cost of production. Sometimes the bauxite is washed, dried, and cleaned before it is shipped.

Bauxite is the chief source of material used in aluminum ware; it is also used in the manufacture of alum, fire bricks, and alundum, an artificial abrasive.

CHAPTER III

CEMENT

Portland cement is made by firing in rotary kilns a mixture of limestone and clay or shale to form clinkers which are then ground with a small amount of gypsum to retard setting. Its many uses with crushed stone, gravel and sand to form concrete are familiar to all.

Georgia is well-blessed with raw materials suitable for the manufacture of Portland cement. Near-by deposits of hard limestones and shales are found in nearly every county in northwest Georgia. Deposits of soft limestone are found in many sections of the Coastal Plain of south Georgia, but suitable clays for mixing with them for the manufacture of Portland cement are not so common, although abundant in certain sections.

At the present time three plants in Georgia are manufacturing Portland cement. Two of these, near Rockmart, Polk County, in northwest Georgia, use near-by deposits of hard limestone and shale. The third, at Clinchfield, seven miles southeast of Perry, Houston County, uses a mixture of soft limestone from a deposit at the plant and a clay (hard kaolin) from Kathleen, six miles north of the plant. Although the capacity of these three plants is more than enough to supply the present consumption of Portland cement in Georgia, they ship to near-by states, and considerable cement made in other states is shipped into Georgia.

CHLORITE

Chlorite is a green magnesium aluminum silicate. It occurs in scales, as does mica, but the scales have a soapy or greasy texture and lack the elasticity of mica.

Chlorite is a common mineral in the Crystalline Belt of Georgia and is frequently abundant in the rocks. At the present time, it is mined in Cherokee County where it is ground and prepared for markets. It is used especially in the preparation of roofing. Other uses are for foundry facings, manufacture of electric insulation, and for lubricating purposes.

CHROMITE

Chromite is a black, heavy mineral which superficially resembles magnetite but lacks its magnetic quality and has a brown streak instead of a black streak. It is an oxide of iron and chromium and is found as veins in rock. The veins are usually broken up by weathering so that the pieces of black chromite may be picked up from loose soil.

Chromite is found in Towns County about two miles due west from Hiwassee. A small amount of chromite ore has been shipped from a deposit near Louise in Troup County. These chromite deposits have not been thoroughly prospected; however, it is generally believed that chromite does not occur in large quantities in these localities. It is also reported from Harris County, five miles west of Waverly Hall.

Chromite is a mineral from which the metal, chromium, is extracted. Chromium is a very important metal used for making the kind of hard steel required for tools used in cutting and drilling at high speed. It is also used in steel for armor plates of battle ships; in stainless steel; in chromium plating other metals; in the manufacture of chrome brick which withstand high temperatures; in the production of pigments, dyes, and for other purposes.

CLAYS

Kaolins

SEDIMENTARY KAOLIN. Sedimentary kaolin, the most important mineral resource in Georgia today, is mined almost entirely within the confines of the Coastal Plain. It is found in Taylor, Bibb, Twiggs, Wilkerson, Baldwin, Hancock, Washington, Glascock, Jefferson and Richmond counties. It occurs in rocks of Cretaceous age.

GEOLOGY. The Cretaceous kaolin beds of the Coastal Plain vary in size from extremely small deposits to huge lenses covering many acres, and may be either a few inches or many feet in thickness. They

CEMENT—*One of the raw materials used in the manufacture of Portland cement is limestone. Top—Soft limestone being scooped up by a steam shovel in Bleckley County. Next below—A cement factory near Perry. Next below—Hard limestone quarry near Rockmart. Bottom—Portland cement plant at Rockmart.*

have been formed no doubt by weathering and breaking down of the Crystalline rocks in the Piedmont section with subsequent transportation and deposition in marine waters. The action of moving water may have sorted out the fine-grained clay materials from the coarser sand particles and deposited them in quiet basins along the shore of the ancient sea which formerly stood at a level considerably higher than that of the present clay deposits. That this is probably true is shown by the fact that the Crystalline rocks contain all the ingredients necessary for the formation of kaolin. Changes in the kaolin have been produced by water action after its deposition. However, some of its properties such as the difference between soft and hard kaolin, are probably original. On the other hand, the flint kaolin may be the result of changes after deposition in which silica leached from beds above has been reprecipitated and concentrated in the underlying kaolin.

HISTORY. The sedimentary kaolins of the Coastal Plain have been known since colonial days. Legend has it that the governor of the province learned of kaolin deposits near Augusta and Macon and had some of the clay taken to Savannah, presumably by Indians, in canoes down the Savannah River and down the Ocmulgee and Altahama to the sea coast. From there it was shipped to the famous Wedgewood Pottery in England. This was about 1741. As early as 1766, Georgia clay was being sent to England in considerable quantities because its excellent value was soon recognized.

This activity continued for about ten years and the industry flourished. Then large quantities of clays in England were discovered and the use of Georgia clays abruptly declined and it was not until about a century later, in 1876, that the mining of Georgia kaolin was revived. The industry then showed a slow and steady growth until recently when it increased production very greatly. For many years Georgia has been the leading producer of kaolin in the United States. Its production accounts for over half of the total value of all minerals produced in the state.

DESCRIPTION OF MINERAL. The mineral, kaolin, is a hydrated silicate of alumina. It is white and pearly, and occurs in hexagonal plates. It has a hardness less than that of the finger nail but this property may vary due to alteration of its original character. In general, kaolins are strictly clay and have a chalky appearance. In fact, they are known locally as "chalk."

Often the color of the kaolin may vary with the iron content, more iron usually producing a redder color. Usually the presence of too

CLAYS—*Georgia is a leading producer of clays used for chinaware, pottery, firebrick, bleaching, sizing, etc. Top—Fuller's earth pit in Twiggs County. Below—Kaolin clay pit in Wilkinson County. Next beolw—Firebrick plant at Macon. Bottom—Small pottery plant in Crawford County.*

much iron oxide destroys the value of the clay as a filler or coating agent for paper.

MINING AND PROCESSING. The sedimentary kaolins are mined by means of steam shovels and drag lines, and in some cases by hand labor. In almost every instance a varying amount of overburden must be removed before the kaolin is reached. Kaolin is loaded into trucks and hauled to a near-by plant for treatment and shipment to markets.

In the processing plant the material is broken down into extremely fine particles and then thoroughly washed. All sand and mica and other detrimental substances are removed and the color of the clay is brought up to the highest degree of whiteness possible, for the largest percentage of the finished product goes into the production of high-grade white paper. A number of large plants in Georgia are equipped with the most modern machinery possible to obtain.

USES. Kaolin has many diversified uses. Among the most important are coating and filling for high-grade white paper. Next in importance is its use as a base for white porcelain ware, highly refractory firebrick, mortars and cements, and as a filler for oil cloths and rubber. In addition, many tons are used in filling white cloth.

Uses for this clay are increasing every year and consequently production figures rise each year. Georgia should be proud of this valuable and extensive mineral resource and should encourage the growth and stability of the industry.

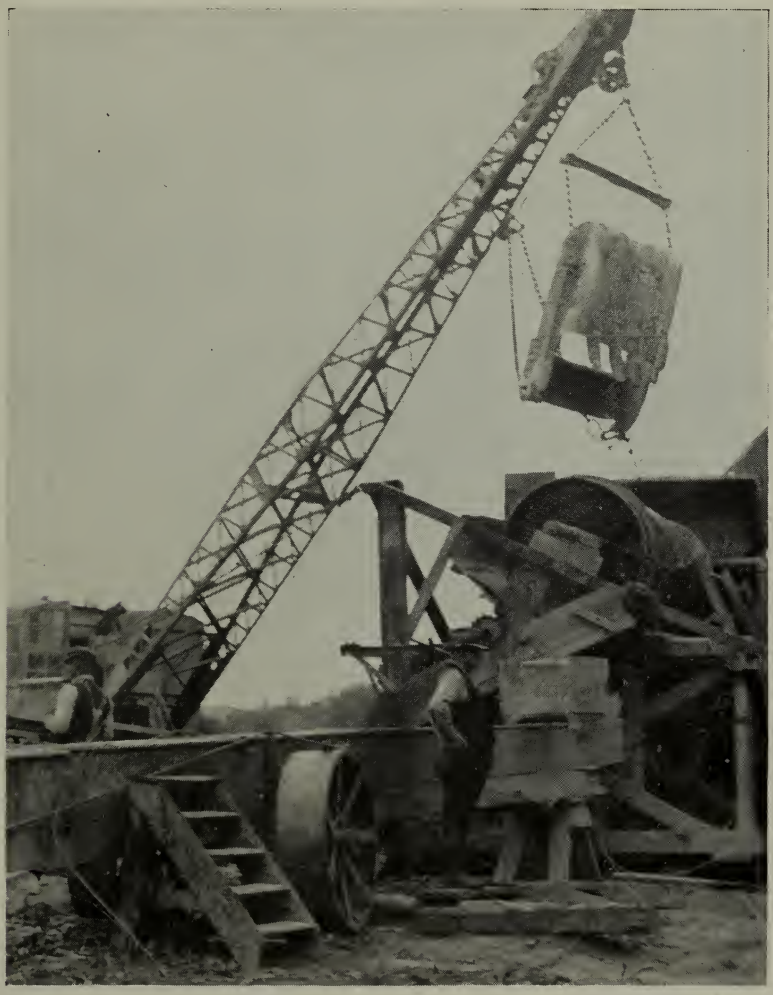
PRIMARY KAOLIN. Primary kaolins are located in the Piedmont section and in the northwestern mountainous area of Georgia. This material has received scarcely any development because it contains greater percentages of detrimental material than the sedimentary kaolin of the Coastal Plain. Consequently, the primary kaolin has a higher mining cost. The primary kaolin deposits are fairly extensive and should be investigated for the purpose of determining their uses, for it is only by research that this material can be eventually utilized.

SHALES AND BRICK CLAYS. Clays suitable for use in the manufacture of any of the common clay products are widely distributed. Clays found along large rivers and shales found in northwest Georgia afford a good quality of material for common building brick. The most excellent brick clays in the state, also suitable for sewer pipe, drain tile, earthen ware, and some roofing tile, are found on terraces along the Chattahoochee, Flint, Ocmulgee and Savannah rivers. They

are being most satisfactorily used at Columbus, Macon, Milledgeville and Augusta.

Other important deposits of clays used for common brick occur near Atlanta and Rome.

SHALES. The shales of Georgia suitable for clay products are found chiefly in the Paleozoic area of northwest Georgia. The most accessible deposits occur in Floyd, Bartow, Gordon, Polk, Whitfield, Murray, Walker and Chattooga counties. Some so-called shales oc-



Modern method of handling clays and loose deposits of ores employed at several mining operations in Georgia. Note the huge dragline boom and attached shovel which has just emptied its contents into the treating plant.

cur in the Piedmont region but these are merely weathered crystalline rocks and are of less value, although increasing in use.

USES. Most of the production from the shale deposits is used in the manufacture of firebrick, roofing tiles and sewer pipes.

BLEACHING CLAYS

All bleaching clays may be divided into two types, those that are naturally active and those that must be activated, or in other words leached with acid.

Fuller's earth falls under the active type of clay classification and bentonite represents the type of clay that must be made active.

FULLER'S EARTH

LOCATION. Fuller's earth deposits of Georgia are located in two regions of the Coastal Plain. One is that area covered by Twiggs, Wilkinson, and Washington counties. The other is Decatur, Grady and Thomas counties.

GEOLOGY. Fuller's earth of Twiggs, Wilkinson and Washington counties occurs in Eocene age rocks. The bed in which they are found is known as the Twiggs clay, which overlies the kaolin deposits of the Cretaceous. Since the Twiggs clay is a member of a rock series containing limestone and sand in addition to the clay, it grades laterally and vertically into limestone and sand. Near Pike's Peak in Twiggs County are two well-defined beds of fuller's earth separated by 50 feet of clayey sand. The upper fuller's earth bed is about 45 feet thick and the lower one is about 20 feet thick. Due to various sedimentary and topographic conditions all clay does not have the same bleaching properties. The beds lie approximately horizontal and contain well-defined strata which indicates that the clay was deposited in the sea. The outcrop follows a definite line which is roughly parallel to the contact of the Coastal Plain sediments and the Cryastilline rocks of the Piedmont. The Twiggs clay is closely associated with the kaolin deposits of the Cretaceous.

HISTORY. Production of fuller's earth in Georgia first took place in 1904, and until 1924 it was second only to Florida. In that year the number of tons produced in Georgia exceeded that of Florida, and since that time Georgia has been the leading producer. The total value of fuller's earth produced in Georgia since 1904 is roughly $18,000,000.

DESCRIPTION OF MINERAL. Fuller's earth is a mineral varying in composition. Its properties of an active bleaching agent are probably due chiefly to physical and not chemical composition.

Common fuller's earth is light-gray, brownish, greenish-gray or bluish in color. It has little or no plasticity but has an unctuous or greasy feel. It usually breaks with a hackly or conchoidal (curved surface) fracture. One of the most distinguishing characteristics of fuller's earth is its light weight. An air-dried sample will often float on water. This property is due to its high porosity. Probably the high bleaching action of the clay is due to this porosity on account of which more surface is exposed to the substance to be bleached. However, this property alone does not account for the total bleaching reaction for there must be other reactions taking place simultaneously which must be partly chemical in nature.

MINING AND USES. Fuller's earth deposits are soft and relatively unconsolidated; consequently they can be mined by steam shovels, draglines or by hand. The largest mines employ mechanical shovels, tramlines, scrapers and other equipment of similar nature.

The mined clay is transported to a nearby mill for processing. This consists of carefully drying to a definite moisture content and then grinding to classified standard sizes, such as 20, 40, 60, 80-mesh and finer sizes. Each size has a definite use in the bleaching of oils. The coarser are used in the percolation method and the fine are used in the contact method of bleaching oils.

Most of the fuller's earth of Twiggs clay is used in bleaching animal and vegetable oils, otherwise known as edible oils. On the other hand, Attapulgus fuller's earth is used almost exclusively to bleach petroleum. The reason these clays are used for definite purposes cannot be explained at this point other than to add that retention of the oil in the clay after bleaching is the determining factor. Animal and vegetable oils are more costly per gallon than petroleum so it is necessary to use for them the clay that has the lowest retention of oil, as a matter of cost. The bleaching power of the two clays also varies considerably in treating petroleum and edible oils.

Other uses of fuller's earth are in the manufacture of some kinds of medicine and soap.

The name "fuller's earth' 'comes from its first use in the "fulling" or cleansing of wool whereby grease stains were removed from the cloth.

Bentonite

Bentonites, as already stated, are clays that are not naturally active but become so by leaching with acid; therefore, they are spoken of as "activable" clays. In Georgia such clays are found in various parts of the Coastal Plain and also in the Paleozoic area of northwest Georgia.

The Coastal Plain deposits occur associated with the Twiggs clay and with the Attapulgus clay, also in a third area to the east of Americus, Georgia.

Geology. The bentonites of northwest Georgia are found in parts of Chattooga, Dade, and Walker counties where there are two zones of clay separated by several feet of massive bluish-gray limestone. The beds have dips ranging up to 45 degrees. Because of the inclination of the beds mining would be very difficult and it is doubtful whether these deposits have much commercial value.

The Coastal Plain bentonites have not been adequately investigated to determine either thickness or extent; consequently little can be said at present about their value.

There has been no commercial development of the bentonitie type of clay in Georgia up to the present time.

Description of Mineral and Uses. The Paleozoic bentonites are greenish-gray to pale-green in color and soft and mealy to hard and brittle in texture. They are slick, soft, somewhat platy, and contain varying amounts of sand.

The Coastal Plain bentonites are usually very similar to fuller's earth, and are thought to be closely related to them. In fact it is necessary to have laboratory tests to distinguish them in many instances.

True bentonites, as found in the western United States and elsewhere, have not been found in Georgia.

Most bentonites are used in the bleaching of petroleum, although some are used in the animal and vegetable oil industries.

"Activated" clays have considerable advantage over naturally active clays, in that they have a very much greater bleaching power per volume. However, due to the increased cost of "activitation," bentonite has little or no commercial advantage over fuller's earth.

CHAPTER IV

COAL

LOCATION. The coal deposits of Georgia are located in the northwestern part of the state, in Walker, Chattooga and Dade counties. Most of the coal beds are confined to Lookout, Sand and Pigeon mountains. Their total area in Georgia covers about 170 square miles.

In Walker County, the most valuable coal seams appear to be those of the Durham property which is located on Ridge Mountain. In Chattooga, the coal seams are limited to a small area in its extreme northwestern corner along the Georgia-Alabama line.

The beds are thin in most places and cannot be worked at present on account of economic conditions. The area of coal deposits in Dade County exceeds that of any other counties. The main coal mining operations were situated on Sand Mountain, but small amounts were mined on Rising Fawn. However, these seams have now been mined out and abandoned and all operations have ceased in that county. Today, only the Durham mine produces coal and that to a very limited extent.

GEOLOGY. The geology of the Georgia coal fields is very simple. Since the seams occur in essentially horizontal beds and in the youngest portion of the Paleozoic rocks, there are few complications in the mining operations. Folding over on a large scale is present, but it is not apparent to the casual observer.

Most important to the miner are those small irregularities, such as faults and variations in thickness in the coal beds. The coal usually occurs interbedded with sandstones and conglomerates, and sometimes may be underlain by clay known as fire clay which sometimes is mined for use in making firebricks.

HISTORY. All the coal mined in Georgia prior to 1899 came from Dade County near Coal City. These mines were operated for about fifty years and then abandoned. The coal seams of Round Mountain and Lookout Mountain were used extensively for blacksmith shops about forty-five years ago. The Durham mines were opened in 1891 and have been operated since that time. Since the World War, these operations have almost ceased and coal mining now exists only locally as "wagon mines."

DESCRIPTION OF MINERAL. Coal has no definite composition but contains various amounts of carbon, sulphides, nitrogen, hydrogen, and water, as well as varying amounts of noncombustible ma-

terial known as ash. Coal is formed by the deposition, disintegration, partial distillation and compaction of organic material which is chiefly the remains of plants. Swamp conditions are favorable to the formation of coal because oxidation of the plant debris cannot easily take place in the waters of such places. The accumulation over many years of vast quantities of plant remains is buried through a change in geologic conditions, and then the weight of the overlying material causes compaction. Thus there are all degrees of coal, depending upon the amount of change having taken place in it since burial. Coal ranges from the lowest to highest ranks as follows: peat, lignite, bituminous, anthracite, and graphite. It can be seen that the higher the rank, the higher is the carbon content.

According to analysis, Georgia coal is low in rank, and is termed semibituminous. Its heating values range from about 32,370 to 35,-100 B. T. U., and the fixed carbon varies between 75 and 80 per cent.

It is a good coking coal as well as a good steam coal. A large number of coke ovens were once operated at Chickamauga, Georgia, with coal from the Durham mine. Perhaps at some future date a satisfactory, cheap method will be discovered to mine the thin coal seams now existing in that area which cannot be mined at present because of high operating costs.

COPPER

LOCATION. The most extensive deposits of copper so far located in the state are to be found in Fannin, Cherokee and Haralson counties. Those in Fannin County are known as the Mobile Mine and "Lot 20." Both of these mines are located in the extreme northern part of the county only a short distance from the Georgia-Tennessee line and within less than three miles of the famous Ducktown copper mining district. These mines may be said to form the southern extension of the Ducktown deposits. The Cherokee copper deposits have been worked at only one place, namely, the Canton copper mine located on the Canton-Marietta public road about one and one-fourth miles south of Canton. The Waldrop copper mine, in Haralson County, is located about four miles northwest of Draketown, near the Haralson-Polk county line. This mine was originally worked as a copper mine but later as a pyrites mine. In addition to the deposits here named, copper is also known to occur in Lincoln, Lumpkin, and Fulton counties.

GEOLOGY. The copper deposits all occur in what is known as the Crystalline area. Those in Fannin, Cherokee, and Haralson coun-

ties are associated with highly metamorphic sediments, probably lower Cambrian in age, while the deposits in Lumpkin, Fulton and Lincoln counties occur in older rocks, probably Archaean. The rocks associated with the copper deposits consist chiefly of highly metamorphic schist, gneisses, and conglomerate, all of which are usually folded and contorted.

MODE OF OCCURRENCE. The copper ore always occur in veins which are often quite variable in both width and longitudinal extent. The veins frequently become so variable in width that they may be spoken of as a series of greatly elongated lenses connected by narrow stringers. They have the appearance of having been deposited along

COPPER—*Mining operation in Fannin County*

crushing or shearing zones and for that reason do not always show well-defined walls. Carl Heinrich, in speaking of the copper veins of Fannin County, says: "All of the ore deposits south of the Oconee River are smaller than the Ducktown ore deposit proper, the ore bodies being smaller and farther apart. They have certainly much less chance of extent either horizontally or in depth, besides being made smaller as a rule; although I have seen slopes in the Mobile Mine 20 and 24 feet wide in places which had been filled with solid ore." The ore bodies on "Lot 20" are said to reach a maximum

width of 15 feet. The ore bodies at the Canton and the Waldrop mines are similar to those of Fannin County but they are generally smaller. In strike and dip the copper veins always conform to the country rock.

CHARACTER OF THE ORES. The ores, for convenience of description, may be divided into three zones. The upper or superficial zone extends from the surface to what may be termed the constant water level and consists mainly of porous, reddish or brownish iron ores known as gossan. This portion of the ore body, which often extends to a depth of 80 feet or more, contains but little or no copper and is therefore of no commercial value, except as an iron ore. Below the gossan is found the black copper zone, which varies from a few inches to a foot or more in thickness and consists mainly of black copper oxide, green and blue carbonates, and occasionally a small amount of native copper in the form of shreds or thin leaves. The third zone lies below the black copper and consists of the unaltered part of the ore body. This part of the vein is made up of pyrrhotite and chalcopyrite, together with quartz, zoisite, hornblende, and other accessory minerals. The ore from this zone carries on an average from 2 to 3 per cent of copper but in some instances it has been known to run much higher.

HISTORY. Practically all of the copper mining in Georgia was done prior to or shortly after the Civil War, and was the direct outgrowth of the discovery of the rich copper deposits in the Ducktown region. It was the prevailing opinion of prospectors at that time that the copper-bearing belt of Tennessee extended southwest through Georgia into Alabama; as a result of this belief there was much prospecting done in Georgia and in a few instances some very favorable prospects were located. Among these prospects were the mines mentioned above, which for a time produced considerable copper. The only reliable date on the production of copper from these old mines are some notes on "Lot 20." Mining operations appear to have commenced in 1861 and in the following year the lessee, Mr. James Phillips, mined and shipped from the property 35.51 tons, valued at $2,451.80. In 1866 the same lessee mined and sold to the Ducktown smelter 246.64 tons, valued at $8,426.87. Subsequent to the last date, the property became involved in a protracted lawsuit and was idle for many years. During the World War the mine was again put in operation and produced a considerable amount of ore. The Mobile Mine, located in the same vicinity as "Lot 20," also produced

considerable copper in the early "sixties," but no reliable record of the production is at hand.

No copper mines are at present operated in the state though the U. S. Geological Survey, as late as 1906, reported 17,182 pounds of blister copper from the Seminole gold mine in Lincoln County where a small smelter was operated for a time. This copper was chiefly a by-product obtained from the gold ores of the Seminole mine.

USES. Copper has various uses. At present nearly 50 per cent of the copper mined in this country is used in the electric industries for copper wire. Considerable amount is also used in the manufacture of brass and castings, as well as sheet copper used for roofing and other purposes. A limited amount of copper is used in coinage. The United States one cent piece contains 95 per cent copper, while all silver and gold coins contain 10 per cent copper.

CORUNDUM

Corundum, an oxide of aluminum, is the hardest mineral known next to the diamond. Common corundum is translucent to opaque and ranges in color from light blue to gray, brown, and black. Transparent varieties, blue (sapphire), red (ruby), and less commonly, yellow and green, are used as gems. Because of its hardness, corundum was once extensively used as an abrasive but has now been almost entirely replaced by artificial abrasives such as carborundum and fused alumina.

Corundum is found in the crystalline area of north Georgia in veins and irregular deposits associated with dark-colored igneous rocks known as peridotites. These rocks and their associated corundum deposits are confined chiefly to a belt some 20 to 40 miles in width that enters Georgia from Alabama in Troup County and extends in a general northeast direction across the state to the North Carolina line in Towns and Rabun counties. Corundum is known to occur in the following counties: Rabun, Towns, Union, Lumpkin, Habersham, Hall, Cherokee, Cobb, Forsyth, Paulding, Douglas, Carroll, Heard, Troup, and Walton.

Corundum was first mined in Georgia in 1873, and from 1880 until 1892, a period of 12 years, Georgia was one of the chief corundum producing states in the Union. The last production recorded from Georgia was in 1893.

The greater part of Georgia's corundum production came from the Laurel Creek Mine on Laurel Creek in the eastern part of Rabun County, about 15 miles east of Clayton. Corundum was discovered

here in the early "seventies" by an Englishman named Thompson. The deposit was worked intermittently during 1873 and 1874 with but poor results, and the mine was abandoned. In 1880, several men living in the neighborhood mined it for asbestos. Their mining was much hampered by the frequent occurrence of hard and heavy rocks which they were forced to remove. The nature of these rocks was unknown to them; consequently they dumped them to one side. This dump was corundum which was recognized by Dr. H. S. Lucas of Chester, Massachusetts, who was prospecting through the region for corundum. He bought the property for the Hampden Emery Company and actively mined it from 1880 until 1892, reaching a depth of 130 feet on a vein averaging 8 feet in width. Work was finally stopped by a cave-in on the best paying vein.

FELDSPAR

Feldspar is the name given to a group of aluminum silicate minerals containing varying amounts of potash, soda, lime, etc. The feldspar minerals are abundant in many crystalline rocks but usually in small grains intimately associated with other minerals. Commercially feldspar is obtained only from veins and dikes of pegmatite which may be termed "giant granite." It is ground and used as a flux in the manufacture of pottery and other white ware, glazes and enamels, glass, and as an abrasive in the manufacture of scouring soaps and powders.

Nearly half of the feldspar produced in the United States comes from North Carolina. The rest is produced from the following states (in order of their production in 1936): South Dakota, New Hampshire, Colorado, Virginia, Maine, New York, California, Connecticut, Arizona, Maryland, and Pennsylvania. Considerable feldspar is imported from Canada. Until about ten years ago there were many small companies producing feldspar and selling it direct to the consumers who often complained that shipments were not uniform in grade and composition. At the present time the feldspar mining companies are nearly all subsidiaries of large grinding and marketing companies.

The feldspar from each mine is hauled to a large grinding plant, stored in separate bins, and carefully analyzed by both chemical and ceramic tests. The different feldspars are then carefully mixed and ground in definite proportions so as to give the exact blend wanted by each consumer. This process, known as chemical control, has given the consumer a product that can be depended upon from year

to year, but has made it difficult to market a deposit of feldspar outside of the principal producing districts.

The mining of mica from pegmatite veins and dikes in many counties in the crystalline area of north Georgia has in many cases exposed feldspar of possible commercial value. In some of the old mica mines the feldspar is too intimately mixed with quartz to be of value; in others the veins are too narrow to be worth working for their feldspar content. But certain of the pegmatite dikes, particularly in Cherokee, Elbert, Rabun, Pickens, Putnam, Monroe, Troup, Upson, and White counties, constitute a valuable reserve of feldspar for the future that will some day be worked. They range in grade from high potash feldspars, such as that at the Kell Mica Mine in Rabun County, through mixtures containing about equal amounts of soda and potash, to the high-soda feldspars such as those near Robertstown in White County.

FLAGSTONE

The decorative flagstone industry in Georgia has a very promising future, although thus far the industry is only locally developed. Flagstone is a rock which may be split into slabs of various thicknesses and adapted to a variety of uses.

LOCATION. Flagstones are derived from a large variety of rock types, occurring in various colors in many parts of Georgia, particularly in the Crystalline Belt. These rocks are quarried in Fannin, Gilmer, Lumpkin, Fulton and other counties in the state. They have a cleavage which permits them to be pried off in slabs of various thicknesses. Variations in color occur from place to place, but shades of green and brown are the most usual. Some of these rocks, as the flagstone at Mineral Bluff in Fannin County, may be split to any desired thickness and can be sawed or cut without difficulty.

USES. In former years flagstones were used for paving walks but the development of modern cement now excludes most flagging from town and city sidewalks. It is extensively used, however, for decorative walks in gardens and around dwellings, and as stone veneer in modern dwellings.

Since flagstone differs in color from place to place, great varieties may be had. Flagging quarried in Fulton County has been used as rock veneer in many new houses in Atlanta. The old custom of building stone houses of one kind of rock creates sameness and monotony; while on the other hand, practically any color effect may be

obtained with stone veneering. Many beautiful effects may be produced by combining flagstone as veneer with such standard building stones as Georgia granite and marble.

FLUORITE

Beautiful specimens of fluorite, calcium fluoride, occurring in cubes or in masses, have been found at several places in Georgia. It is slightly fluorescent. (It glows when exposed to ultraviolet light.)

Fine specimens of green fluorite occur near Ranger, Gordon County. Amethyst-colored cubes are found in limestone at Graysville in Chattooga County.

Fluorite is used principally as a flux in smelting ore, in the manufacture of opalescent glass and hydrofluoric acid. The Georgia deposits have not been adequately prospected.

CHAPTER V

GOLD

The chapter on gold deposits is offered as a contribution to the economic geology of Georgia with the aim of furnishing comprehensive and as far as possible definite ideas as to their existence and mining possibilities.

Prior to the discovery of gold in California, the Southern Appalachian gold fields of which these deposits formed an important portion, received almost exclusively the attention of the gold miners of the United States. With the rush to California and the discovery of gold in other western states, the Georgia mines were in large part abandoned by professional miners and either lay idle for many years or were worked to a limited extent by local owners. The War Between the States and the subsequent demoralized state of business in Georgia retarded further development for a considerable period. Later, with the revival of business in the South, companies were formed and mines on all the more important belts were operated. In a number of cases the ore bodies were worked below water level and an attempt made to treat the refractory sulphide ores by the cyanide or chlorination method. Apparently the most successful attempt to operate included milling the ore, collecting the free gold by amalgamation (with mercury), and concentrating the sulphides for possible treatment by other methods. At many localities the veins were sluiced with hydraulic giants through large open cuts into mills situated at lower levels. The depth to which such deposits could be worked in this

manner was determined by the degree to which the country rock had been decomposed. With some modifications, these methods of mining, considering veins only, are in practice at the present time.

GOLD—*Gold is found in numerous places in North Georgia. Top—Hydraulic mining, or washing gold from the earth. Below—Dredging in Lumpkin County to obtain the gold in the sediments of stream beds. Bottom—Tunnel entrance to underground mining operation.*

Unfortunately in many cases the parties controlling and directing the operations were business men with little or no experience in gold mining, which resulted in frequent errors of judgment in equipping plants, locating shafts, etc. Particularly regrettable was the erection, in many instances, of mining plants when neither the quality nor necessary quantity of ore had received other than the most meager tests. Other instances of poor judgment resulted in the installation of certain types of equipment wholly unsuited to treatment of the type of material being mined. As a rule, under these conditions, after varying periods of operation these efforts were rewarded with failure.

Only in recent years have conditions, such as availability of proper equipment, effective methods of treatment and adequate electric power, been favorable for gold mining in Georgia.

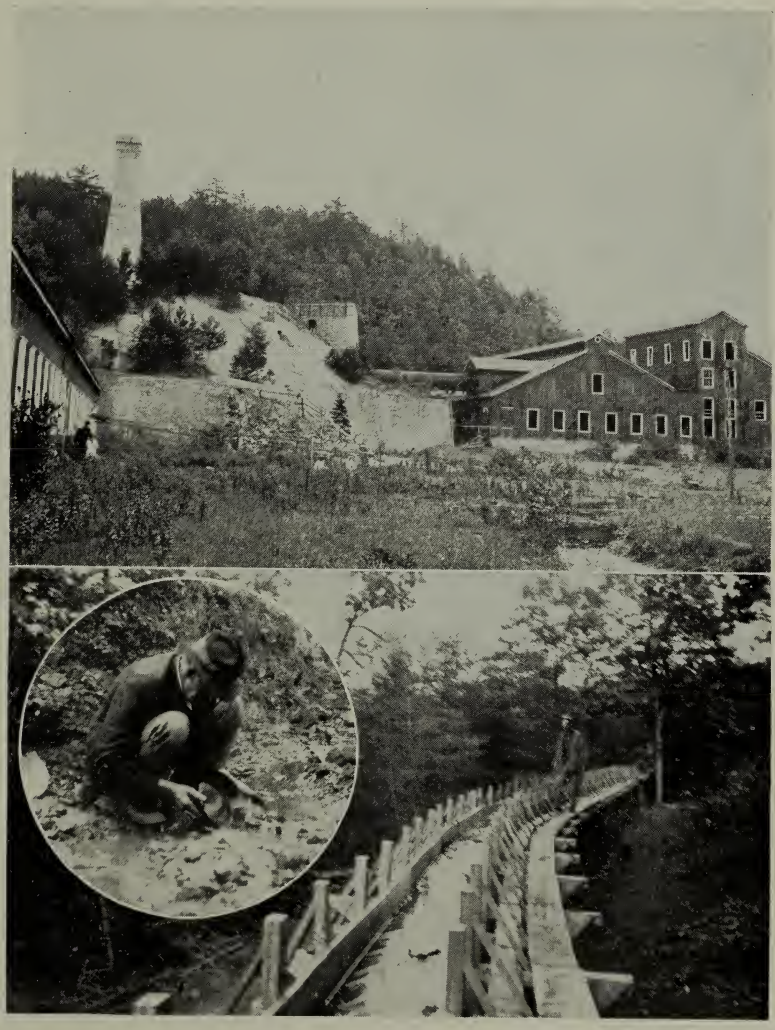
Mining engineers familiar with the gold fields of Georgia concur in the opinion that if deposits of a similar character existed in any of the more important gold producing states of the West, they would have been much more extensively exploited. This is doubtless true; and a detailed survey of the territory confirms the belief that the Georgia deposits, especially in recent years, have not received the attention and tests they merit as judged by operations in many other gold yielding regions.

The conditions for mining Georgia deposits are very favorable. Water, and in many cases, water power are abundant; timber for construction purposes is plentiful and can also be obtained cheaply for fuel if desired. The price paid for labor in the mining districts is reasonable; transportation facilities are good; railways or paved highways either pass through various sections of the gold belt or lie closely parallel to them. There are no extremes of climate to contend with and the proximity of manufacturing cities like Atlanta, Augusta, Savannah, Chattanooga, and Birmingham renders the obtaining of supplies easy. In addition to the foregoing, increase in the price of gold from $20.67 per troy ounce to $35.00 per troy ounce should render certain areas or deposits available for economical operation that formerly were on the border line between commercial and noncommercial ore.

History and Statistics. It is thought by some that gold was mined to a limited extent in Georgia by Spanish explorers when De Soto's expedition passed through the state. Several traditions also credit the aboriginal tribes with having discovered and secured placer gold, especially in the Dahlonega district of Lumpkin County. It is probable that the Indians found nuggets in this region, and prizing

them, doubtless learned to search for them at favorable localities. But the suggestion by some writers that they washed gold out of the stream beds seems unlikely when the difficulty of getting down to the bedrock of the average Appalahian stream carrying its large load of sand and boulders is considered.

In 1829 gold was discovered nearly simultaneously in the Nacoochee Valley region of White County and near Dahlonega in Lumpkin



GOLD—*Mill and chlorination plant in Lumpkin County. Flume carrying water or ore to a treatment plant. Inset—An old miner panning gold along a mountain stream in Georgia.*

County. (It is claimed that gold was discovered prior to this date in McDuffie County in the vicinity of the Columbia Mine. *Trans. Am. Inst. Mining Engineers,* 1903, Vol. XXXIII, p. 119-125.) Many of the placer deposits of these two regions, occurring along small branches and creeks, were exceedingly rich and easily worked, and active mining followed the discovery. From these two centers mining operations gradually spread to other localities.

By 1838 the production of gold in Georgia had become of sufficient magnitude to warrant the establishment by the United States government of a branch mint in that section. This mint was located at Dahlonega in Lumpkin County, and operated from the date just mentioned until the year 1861, the time of the secession of Georgia from the United States. The report of the United States Treasury Department shows a total coinage at Dahlonega during that period of $6,115,569.00. From statistics from the director of the mint and other sources it is estimated that the entire production of gold in Georgia from early discoveries to 1909 has amounted to about $17,500,000. The yield has fluctuated greatly in different years, the largest output per annum having occurred prior to the Civil War and before the more important placers were exhausted.

Before the War Between the States, while the major portion of production was derived from placer deposits, vein mining was not neglected. The operations however were limited to the mining of free-milling ore and when the level of ground water was reached the mines were often abandoned. Stamp mills of small capacity, not infrequently manufactured by the miners themselves out of oak timbers with iron shod shoes and dies, were used for crushing the ore and in some cases arrastres were employed.

During the period of the war above mentioned and for several subsequent years, mining was practically at a standstill. With the resumption of business in the South, gold mining was renewed, and with the gradual introduction of improved methods, efforts were redoubled toward the successful mining and milling of refractory ores.

Gold is obtained in nature either from veins or beds in the rocks, both hard and soft, or from the placers. In the rocks it is sometimes diffused throughout the mass in fine particles, but is generally in connection with veins of quartz in the form of ragged masses and filaments, or is enclosed in masses of pyrite.

VEIN DEPOSITS. Several varieties of veins are to be noted. The predominant types are fissure veins (The term, fissure vein, is not here restricted, as is frequently the usage of gold miners, to veins cut-

ting the trend of the enclosing rocks at an angle.) conforming in the main to the trend of the enclosing country rock which is usually northeast-southwest. Thin stringers running out from the vein for short distances into the wall rock are common. The veins conforming to the schistosity of the enclosing rocks pinch and swell both horizontally and vertically, causing one of the greatest difficulties attendant on mining this class of deposits. Beds of ore fifteen to twenty feet in thickness may occur at some points while a short distance away on the same level a small stringer or seam of quartz may be all that represents the vein.

At some mines it has been noted that the pinches and swells occur with a fair degree of regularity, so that the miner may predict with reasonable accuracy just how far it will be from one enlarged ore zone to another.

In connection with the veins, there is a type of deposit which may be designated as gold-bearing zones. These zones consist, as the name implies, of many more or less comformable quartz stringers, or lenses of quartz with country rock, having in most cases the trend of the local formations, but being sufficiently unconformably mineralized with gold to designate gold-bearing zones. They vary from one foot or two to several yards in thickness. Frequently several more or less parallel zones, ranging from a few to twenty or thirty feet in thickness, occur closely associated, thus forming a major zone which in some cases may be several hundred feet in width, the strike of which in some instances may be followed for several miles. In these large zones the paying values, as would be expected, are limited to bands and restricted areas. It is along the outcrop of these gold-bearing zones that the saprolite deposits previously mentioned frequently occur. As massive bodies of gold-bearing quartz are sometimes found along with the stringers, the zone deposits grade on the one hand into saprolite deposits and on the other into ordinary vein deposits, the upper decomposed portion being worked by hydraulicking or shovels as a saprolite deposit; while the bunches of quartz are mined through shafts sunk into the hard formation. The gold-bearing zones are frequently spoken of locally as gold-bearing belts.

In addition to interfoliated veins, others cutting the schistosity of the enclosing rocks at various angles are not uncommon. These are generally spoken of as true fissure veins and it is believed that they are more uniform and persistent than the other class. This type of vein is quite common in the McDuffie belt and a number of them have been good producers. W. H. Fluker's property, twelve miles north-

west of Thomson, Georgia, affords a good example of this type of vein.

In size, the veins in Georgia, as in other sections of the Southern Appalachian gold fields, vary from a few inches to over twenty feet in thickness. The outcrop of many of the large veins is very noticeable and shows them in some cases holding their width quite uniformly for considerable distances.

Instances might be cited where numbers of small veins only a few inches in thickness that contained astonishingly large amounts of gold have been mined at various localities. However, veins large enough to warrant the erection of a large scale mining plant with the expectations of long continued operations should not be expected to yield what would ordinarily be considered very high values. An average in such cases of from $7.00 to $15.00 per ton may be considered good. In regard to the occurrence of gold in the vein, it may be stated that in most gold-bearing quartz veins the gold is largely associated with iron pyrites. The extent of the association, however, seems to vary in different localities and in individual veins. In some cases a considerable percentage of the gold below the zone of deposition of sulphides is found free in the quartz and can be recovered by amalgamation, in other cases, an assay of the milky white vein quartz from which the sulphides have been removed will show that only a very small percentage of the total is free gold.

The distribution of gold in the veins is rarely uniform but varies both laterally and vertically, and the values are frequently found in ore chutes, generally pitching along the strike of the veins at a rather steep angle.

PLACER DEPOSITS. The placer deposits bear a close relation to the vein deposits; that is, in sections where the veins are most numerous and carry good values, the placers have been found to be proportionately rich. In placers the gold is in loose rounded masses, in scales or grains, or in fine dust-like particles disseminated in gravel, sand, and clay, and is transported like them from place to place by water. The gold, like the pebbles, is thus worn into rounded masses and grains by constant rolling and attrition. It is a golden detritus, formed by the breaking down and washing away of the upper portions of pre-existing veins. The gold is thus in a secondary condition, having been broken from its original matrix and spread out with the fragments of the rocks and veins over the surface of the country. The great agent of this abrasion and transportation was water, very likely in powerful currents or river torrents, running over what are now the

tops of the hills. This is proved by the existence of ancient river beds high above the present stream levels.

The size of the fragments of gold in placers is determined in the first place, by the original size of the masses or filaments in the veins; and, secondly, by the amount of wear to which they have been subjected after their liberation from the enclosing rock. In general, coarse fragments of gold are found relatively near the original sources, while the smaller and much more waterworn particles are found at greater distances from their source.

Thus by the agency of drainage water gold is distributed with gravel over hills and valleys and in the beds of the streams. In placer deposits the greater part of the gold settles to the bottom and is generally found resting on the surface of the unmoved formation, which is commonly spoken of by miners as slate or bedrock.

All these accumulations of gold in gravel and sand, which have been broken from veins and beds and transported to lower levels by water, are generally referred to as placers.

The placer or gold bearing gravel deposits may be classed as both ancient and modern. It is difficult, however, to draw a line between the two classes at many localities. These heavy beds of thoroughly waterworn gravel are frequently overtopped with considerable thicknesses of sand and clay. In some cases tenacious blue clay is mixed with the gravels and forms a layer several feet in thickness immediately above the gravel beds. The majority of the true gold-bearing placer gold deposits of Georgia are found associated with present drainage systems and are therefore located along our present streams. A good type of such deposits may be seen in the broad valleys of the streams in Nacoochee Valley, in White County. These broad deposits owe their origin to a flooded condition of the streams during a period of subsidence.

In the past, these placer deposits have been mined principally by hydraulic methods, although in some instances, such as along the Chestatee River in Lumpkin County, dredge boats have been employed to a limited extent.

Doubtless the great majority of the placer deposits in Georgia have been located and a large percentage extensively worked with old methods, many having been reworked a number of times. The future of placer mining in Georgia will be a matter of reworking these old deposits by modern methods, using dragline excavators, dredges, or any system that can handle large amounts of alluvium more cheaply than was possible by more primitive methods. Working with a drag-

line excavator, a few men under favorable conditions can handle a sufficient amount of placer material each day to make operations profitable even when the gold content of the deposit is as low as 15 cents per cubic yard. At various localities along the gold belt old methods of placer mining are still being used, but miners who are making more than a modest daily wage by such methods are exceptional.

SAPROLITE DEPOSITS. The saprolite deposits in Georgia form a rather unique class of gold deposits. The rocks in this section are deeply decayed at many localities. The decayed product is found in place, there having been no glacial action to remove the decomposed rock material.

These gold-bearing bodies of decomposed rock consist of more or less disintegrated quartz veins and many small stringers of quartz. In some cases the veins of quartz may be very small, occurring as numerous tiny stringers and seams; and in other cases the veins may be of sufficient size to form workable ore bodies. The saprolites have been extensively worked by sluicing the material through flumes to mills located at some point below the level of the cuts thus formed. Some of the gold is saved by amalgamation in the sluice boxes and the fine portion of the sluiced material is conducted to ore bins near the mills in which it is to be treated. The larger pieces of quartz and other hard material are removed by grizzlies or some similar contrivance before the main stream reaches the ore bins. This material may be treated by whatever processes will recover the values.

Immense cuts have been made in the hills in Lumpkin County in working these saprolite deposits. A cut of the Barlow Mine near Dahlonega, Georgia, is over one-half mile in length. At this great cut there was formerly a mill at either end, the material being sluiced both ways.

Although these deposits are largely worked by washing, they are not to be confused with true placer deposits in which the gold has been concentrated by the transporting power of water. In saprolite deposits concentration of gold has taken place in two ways: (1) By the removal of portions of the rock ingredients in solution, while the insoluble part and gold are left behind; (A given amount by weight of the saprolite would thus contain a greater amount of gold than the same quantity of the original, unaltered rock.) (2) Also gold freed by surface weathering from the quatrz stringers or from the rock, on account of its high specific gravity, would tend to settle into cracks and crevices and work its way downward for a short

distance into the more or less porous mass of the upper part of the rotten rock.

Different observers seem to have arrived at different conclusions concerning the percentage of the gold that has been saved and lost by the methods of mining employed in the past. There seems to be fairly general agreement, however, to the effect that quite a large percentage of the saprolitic gold was lost due to its fine size or to the fact that it was flaky, or that the individual grains or particles were coated either with clay or certain metallic oxides. Quite likely the principal contributing cause of the loss of gold by the treatment used was the fact that this material was largely clayey in character and relatively low grade so far as gold content was concerned. Since the miners had available only a limited amount of water with which to mine and wash their ore, they did not succeed in cleaning the individual grains of gold, especially the finer particles, with the result that such uncleaned particles in a stream of very muddy water reacted more like clay than gold and floated away with the tailings.

The fineness, that is the percentage purity of Georgia gold, is high at nearly all localities where it has been mined. The Loud Mine, in White County, is an exception to the rule. The gold there has been reported as 0.800 (80%) and even lower. At the placer along Coosa Creek, in Union County, it is claimed that the gold has the fineness of 0.980 (98%). The general average is probably 0.950 (95%) or higher.

Geographical and Geological Distribution of Gold Deposits. Gold deposits of Georgia are found in a portion of a broad zone of country stretching from near the center of Alabama northeastward into Maryland and lying principally southeast of the Blue Ridge Mountains. In Georgia, this zone takes in the greater portion of the Piedmont Plateau and a part of the physiographic provinces of the Appalachian Mountains.

Auriferous (gold-bearing) areas, in which are found gold-bearing quartz veins and other forms of deposits, occur throughout this region, generally as more or less parallel belts of relatively narrow lateral dimensions, but they are found at some localities as small isolated areas or patches.

In Georgia, the larger portions, by far, of auriferous areas occur in well-defined belts and show, as will be seen by referring to the map accompanying, as bands of varying width running nearly parallel in a northeast and southwest direction. In addition to the belts, a few isolated areas are found in the same section in which

the belts occur. It will be seen from the map that all of the deposits are north of the Fall Line, a line formed by the junction of the Piedmont Region and the Coastal Plain. The belts parallel the axis of the Blue Ridge Mountains and most of them lie southeast of this axis. These additional belts are here described.

DAHLONEGA BELT. The Dahlonega Belt enters Georgia from Alabama and passes through Haralson and Paulding counties, parts of Cobb and Bartow counties, traverses Cherokee County and the northwest corner of Forsyth County, and from thence passes through Dawson, Lumpkin, White, Habersham, and Rabun counties into North Carolina. This belt has the length of about 150 miles and width varying from two to six miles.

HALL COUNTY BELT. The Hall County Belt commences in Fulton County, runs through Forsyth, Gwinnett, Hall, Habersham, and Rabun counties. This belt is approximately 100 miles in length.

MCDUFFIE COUNTY BELT. The McDuffie County Belt originates in the northeastern corner of Warren County, runs northeast through the northern portion of McDuffie County, the southeast corner of Wilkes County and from thence through Lincoln County to the Savannah River. The McDuffie Belt is nearer the Coastal Plain than any other known belt, its distance from the Fall Line being about 20 miles. The length of this belt in Georgia is about 30 miles, with an average width of about two miles.

CARROLL COUNTY BELT. The Carroll County Belt commences in the western part of Carroll County and runs through Douglas, Paulding, and Cobb counties, where it joins the Dahlonega belt. Its length is about 50 miles and its greatest width about two miles.

OGLETHORPE COUNTY BELT. This belt runs through the northeastern portion of Oglethorpe County. Its length is approximately 25 miles and its width about two miles.

MADISON COUNTY BELT. This belt occurs in Madison and Elbert counties and extends from a point near Comer, in Madison County, to a point about three miles northeast of Bowman, in Elbert County. Its apparent length is about 10 miles.

All of the belts, the localities which have thus far been described, lie, excepting a small portion of the Dahlonega Belt in Rabun County, south or southeast of the crest of the Blue Ridge Mountains. The following belts are found north of the crest of the Blue Ridge.

GUMLOG BELT. The Gumlog Belt runs from a point a little south of the Gumlog Mine in the northern part of Union County northeast through the northwest corner of Towns County into North Carolina. Its length in Georgia, as far as it is known, is about eight miles.

COOSA CREEK BELT. This belt runs from near the headwaters of Coosa Creek in Union County northeast to a point near Young Harris in Towns County. Its length is about 15 miles.

HIGHTOWER CREEK BELT. The Hightower Creek Belt runs from near Mountain Scene on the headwaters of Hiawassee River in Towns County northeast to within a few miles of the Georgia-North Carolina line. Its length is about 10 miles.

ISOLATED AREAS. In addition to the well-defined belts mentioned above, a number of localities are to be noted where gold has been found in isolated areas. It is probable that future prospecting will connect a portion of them, at least, into belts of the usual northeast-southwest trend. The more important of these isolated areas are found in Fannin, Gilmer, Lincoln, Hall, Cherokee, Meriwether, Forsyth, Wilkes, Hall, Warren, Coweta, Newton, Henry and Clarke counties.

All of the gold deposits of Georgia, geologically considered, occur in the large area designated as "igneous and metamorphic." This area is commonly known as the Crystalline Area, and is composed of rocks that have, for the most part, been changed by metamorphism from one type of rock into another more complex type.

GEOLOGY AND GENESIS

GEOLOGY. The geological formations in which gold-bearing veins occur are the most ancient in the state, and among the oldest of all the formations of the North American Continent. The auriferous veins were probably formed during the closing period of the earth's last crust movement that produced important changes in the structure in the rocks. The evidence that their age does not exceed this is found in the fact that the majority of them do not show any large amount of faulting or crushing.

GENESIS. Conclusions concerning the genesis of the veins and the source from which the gold and other constituents were derived, must be based, in the region under consideration, principally on theoretic considerations. There are certain features in the gold veins in

Georgia that point to the deposition of the ores from heated solutions coming from great depths. In other words, it is believed the veins had their roots deep-seated when formed. It is believed possible that rock masses once rose above the present surface to the height of at least one mile. The extensive formations of sands and clays, whose material was derived from the weathering of the rocks of the Piedmont Region, that are found south of the Fall Line in Georgia add their testimony to the great erosion of the plateau in the past. Granites and granite-gneisses are a common occurrence in the neighbood of many of Georgia's gold deposits. This fact might well make any theory referring the source of the gold to the magma of these rocks a tenable one.

For a more detailed description of the Georgia gold deposits, refer to Geological Survey of Georgia, Bulletin 4-A, *Gold Deposits of Georgia,* by Yeates, McCallie, and King; and to Bulletin 19, *Gold Deposits of Georgia,* by S. P. Jones.

Both publications are available for reference at the office of the Division of Mines, Mining and Geology, State Capitol, Atlanta, Georgia, and in most public libraries of colleges and universities.

Gold Recovery Processes

The following are some of the processes, both ancient and modern, that have been employed in the treatment of gold-bearing material for the purpose of recovering the precious metal. Beginning with the most primitive up to the most modern of present time, they are panning and vanning (winnowing); rocker and long tom; sluice box; primitive stamp mill and modern stamp mill; chlorination and cyanidation.

Panning or Vanninc. Panning of gold was one of the earliest methods used in separating metallic gold from more or less distintegrated rock or sand. The operation proper usually consisted in filling a pan, 8 to 14 inches in diameter and 2 to 4 inches in depth, with from 5 to 10 pounds of gold-bearing sand or material. The pan filled with this gold-bearing material is submerged in water, either a stream or tub, and allowed to become thoroughly wet—this wetting may be assisted by more or less kneading with the fingers; next the operator shakes and rotates the pan while holding it beneath the surface of the water, thus causing the heavier sand particles and materials to gradually work their way through the beds of material to the bottom of the pan. While moving the pan from side to side, thus creating wave motion, the pan is tilted in such a manner as to cause the coarse,

light material to gravitate to one side of the pan; from thence, the operator, with his fingers, rakes off the top layer of light worthless material, being careful not to rake deeply enough to disturb the gold which should now be resting at the lowest point in the pan and underneath the bulk of material. The pan is now leveled off and the operator again goes through the shaking and rotating motion described above. This procedure is repeated again and again until only a few teaspoonfuls of material remain in the pan. The small amount remaining consists mainly of black sands such as heavy oxides and metallic grains, including any gold originally present in the gold-bearing material. By covering this sand with a small amount of water, say one-half teacup or less, and causing the water to swish back and forth over the small amount of sand, it will be noticed that the sand tends to travel in a circular motion around the bottom of the pan while the gold and other heavy metals, being heavier than the sand itself, tend to tail or lag behind and may be seen by the unaided eye. Formerly many "old timers" made a living in this manner.

Today panning is sometimes resorted to by placer miners as a quick method of assay in determining whether or not a deposit of gold-bearing material is of commercial grade.

ROCKER AND LONG TOM. The rocker and long tom methods are simply large scale panning operations employing, instead of the pan, a short box in the case of the rocker and a large box in the case of a long tom, both being equipped with rockers very similar to those on the old-time baby crib. Both the rocker and the long tom are usually equipped with a screen at one end on which is dropped the material to be washed. Coarse material is raked off immediately, and the fine material which goes through the screen is caused to swish back and forth as it travels the full length of the box. Some sort of crevices or riffles are present in the bottom of the boxes in order to make a place in which the heavy sand and metals will lodge, while the lighter and more worthless material is made to discharge at the lower end of the boxes. At regular intervals the sand and the metals collected in the riffles are collected in an ordinary pan for further concentration and recovery of the values.

This method of gold recovery was very popular in the early days and prior to the advent of the modern stamp mill.

SLUICE BOX. A sluice box is simply a long wooden trough with a rack made of strips of wood with about one inch space between strips and which is fastened to the bottom and runs the full length of the trough. This trough is placed with one end lower than the other,

so that when water and dirt or sand are introduced at the upper end, the water causes the lighter, worthless material to be carried through and discharged at the lower end of the box. The heavy sands and metals such as gold lodge between the riffles or slats. At irregular intervals, depending on how much material has been washed through the box, the operation is discontinued. Then most of the water running through the box is cut off; the riffles (racks) are then lifted out, carefully washed off, and laid to one side. The concentrate including the gold is caught in a tub and is further concentrated by panning to recover the gold.

PRIMITIVE STAMP MILL. The earliest type of crushing and grinding equipment, which may be referred to as an adherent of the stamp mill method, consisted of a spring pole arrangement. A green sapling some 15 or 20 feet in length was arranged with the butt fastened between the fork of a tree in such a manner that the tip was suspended in an inclined manner, sloping upward. From the top of the pole was suspended a section of green bough equipped with a metal shoe at the lower end. Some sort of dish-shaped metal or other type of die was placed on the ground directly underneath the suspended "shod-bough." Pieces of rock or ore were placed in the dish-shaped die on each downward stroke. By this means the rock was crushed and more or less pulverized. Usually the pulverized sands were treated in the pan to recover the values.

The next step in the development of the stamp mill consisted in arranging from two to five heavy posts in a group or battery. Each post was shod at the lower end with a metal shoe and was equipped near the upper end with an offset, or a collar, in such a manner as to allow cams, fastened to a horizontal wooden shaft, to lift each post (or stamp stem) as the cams were caused to rotate. Each post worked up and down through guides, and each shod end of the posts (or stamp stems) was made to drop on the dies arranged in a rectangular box known as a mortar. The front of the rectangular box was equipped with some sort of a screen which would allow material, ground to the desired fineness to discharge from the box (mortar), but would retain coarser material in the box for further grinding.

The fine material, discharging from the box or mortar, was caused to run over blankets spread on inclined tables. The gold would stop on the blanket while the worthless material would be washed away. At regular intervals these blankets were taken up and the gold washed out into tubs from which it was collected by panning. Water wheels usually supplied the power applied for operating these stamp mills.

Modern Stamp Mill. The modern stamp mill is somewhat similar in arrangement to that of primitive methods; but in the modern mill there are no wooden parts. Steel rods are used for the posts or stamp sets and heavy weights are fastened to the end of each rod. The cams are made of steel and the box or mortar is usually cast in one piece of either cast iron or steel. A modern stamp mill is almost a complete milling process within itself; that is, it crushes, grinds, classifies, and amalgamates gold all in one operation. In the modern stamp mill, copper plates coated with mercury and arranged on inclined tables replace the woolen blankets used in the primitive mills for extracting the gold from the fine sands and pulp discharged from the stamp mill. For separating very rich ores in the stamp mill, mercury is added to the box or battery to form an amalgam with the coarse particles of gold which may be liberated from the rock during the crushing process. At regular intervals, the mill is shut down, the screen removed from the front of the box or mortar, the stamps raised to their highest point and there propped up, the dies removed from the mortar box, and the amalgam and heavy sand are taken out.

The gold and mercury (amalgam) which has collected on the surface of the copper plates are next removed by scraping with some instrument, such as a putty knife or a strip of hard rubber. The amalgam removed in this fashion is usually a silvery mass of more or less puttylike consistency and is placed in a closed iron retort. When heat is applied to this retort, the mecury vaporizes and passed on through an opening in the lid in the retort and then goes into a water-cooled discharge pipe which causes the vaporized mercury to recondense. The gold will not volatlize or vaporize and is left as a residue, called "gold sponge," in the bottom of the retort. The gold is then shipped to the mint, and the recondensed mercury may be used over again.

Chlorination and Cyanidation. Gold ores consisting, in addition to gold, of certain compounds such as iron sulphides (pyrite) cannot be treated successfully by simple amalgamation processes. The ore is washed, ground to a fine powder, either in a stamp mill or other type of grinding machinery, and the resultant ore is treated with chlorine gas or a weak solution of potassium or sodium cyanide. Gold is not soluble in any single acid but is soluble in chlorine gas and cyanide solution.

After the pulp has been treated with the chlorine or cyanide, the gold-bearing solution is drawn off, filtered to remove the mud, and then run into vats where chemicals are added to precipitate the gold.

The precipitated gold settles to the bottom in the form of a sludge. The clear liquid is drawn off, after which the sludge is removed from the vat, dried, and converted into gold bullion.

There are many modifications of the foregoing processes. Many of these are quite modern and complicated, depending on the type of gold ore being treated.

CHAPTER VI

GRANITE

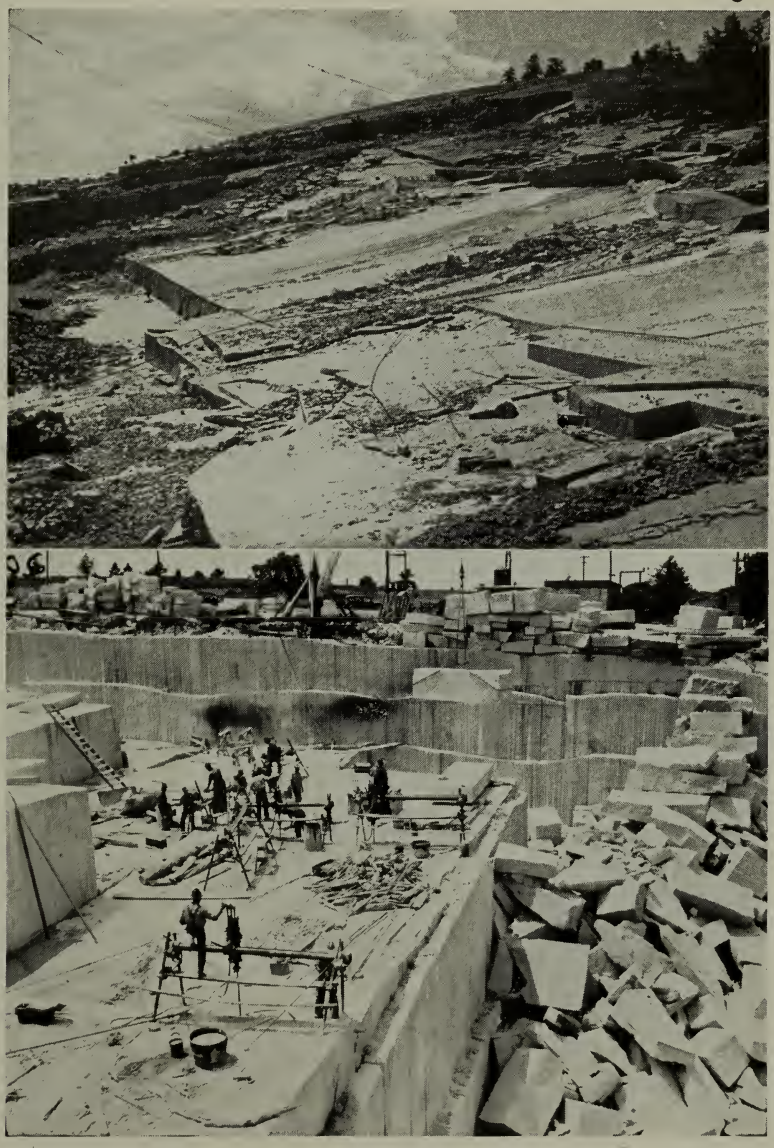
Granite is a granular, igneous rock composed essentially of quartz, feldspar, and mica—as muscovite or biotite or both. It very commonly contains hornblende and may contain minor amounts of other minerals. It is valuable because of its strength, its hardness, and its ability to take a polish. Granite in which the dark minerals are arranged in parallel or wavy bands is known as granite gneiss (pronounced "nice").

USES. The uses of granite may be divided into two classes: (1) dimension stone, which includes building stone, monumental stone, curbing, and paving blocks; and (2) crushed and broken stone which includes riprap, rubble, concrete aggregate, road metal, railroad ballast, and artificial sand.

LOCATION. Granites and granite gneisses of Georgia are found only in the crystalline area of north Georgia, but are widely distributed throughout this area in deposits that are practically inexhaustible. The principal quarrying centers for dimension granite are Elberton, Stone Mountain and Lithonia, although some is quarried near Greensboro and Sparta. The producers of broken and crushed granite are more widely scattered and range from large permanent quarries and crushing plants to small portable or semiportable crushers that are moved around to meet the demands of some large construction job. The counties in which granite was produced in 1937 in 62 different quarries are: Banks, Butts, Carroll, Cobb, Columbia, DeKalb, Elbert, Fannin, Fulton, Greene, Gwinnett, Habersham, Hancock, Henry, Lincoln, Lumpkin, Madison, Oglethorpe, Rabun, Spalding, Stevens, Towns, Union, and Warren.

GEOLOGY. The crystalline area of Georgia is underlain by dense crystalline igneous and metamorphic rocks the origin of which are veiled in mystery. Some of the schists and gneisses may have once

been sedimentary rocks laid down in an unknown ocean that covered parts of Georgia during the earliest era of geologic time, hundreds of millions of years ago. That first long era of geologic time was ended by a period of mountain building during which the original sedi-



GRANITE—*Above—A Stone Mountain granite quarry in DeKalb County. Below—Granite quarry in Elbert County.*

mentary rocks were folded and thrust up into huge mountains which were intruded by large masses of igneous rocks, then completely metamorphosed or altered by heat and pressure. Some of our granite gneisses may have formed at that time. The crystalline area has continuously been above sea level since that time and the constant erosion of streams throughout the millions of years has worn these old mountains down so that now we see just their roots in our gently rolling Piedmont area.

The Paleozoic era, the next long geologic age, was again ended by a period of mountain building, during which our present Appalachian Mountains were formed. This time of mountain building was also accompanied by folding and metaphorism of the rocks and intrusion of more igneous rocks, including most of our uniform monumental granite and some of the granite gneisses. Erosion since that time has been wearing down these mountains until we now have left in the mountains of north Georgia only the remnants of what was once a mighty range of mountains possibly higher than the Rockies or the Alps.

As the land was slowly worn down by stream erosion these last solidified granites, at first far beneath what was then the surface, were finally exposed to view. Some of the granites were harder than surrounding rocks and were left standing up as isolated mountains such as Stone Mountain. Other granites were about equal in hardness to the surrounding rocks and are now exposed as flat-rock outcrops, such as many of the exposures of granite in the Elberton district.

Three main varieties of granite are quarried in Georgia: (1) the uniform-textured granites of the Stone Mountain and Elberton districts; (2) the granite gneisses, such as those of the Lithonia district in which the dark minerals are arranged in wavy or parallel bands; and (3) the porphyritic granites, such as those of the Greensboro and Sparta districts, in which some of the feldspar occurs as large crystals surrounded by a fine-grained ground mass, giving a pleasing mottled appearance.

The Stone Mountain granite is an even-textured, medium-grained, light-gray muscovite-biotite granite, very uniform throughout in color and texture. It is well adapted to building purposes and for bridges and mausoleums, and it is available in sound blocks of any desired size. Paving blocks, curbing, rubble, and a limited amount of monumental stock are also produced. The waste is used as rubble and some is crushed. In 1937 four companies were operating in the district.

The Elberton granite occurs in two main types—a fine to medium-grained, light-gray, biotite granite and a dark blue-gray granite simi-

lar to the first, except in color. The former is best for building purposes. The blue-gray granite is so uniform in texture, attractive in appearance, and presents such a contrast in color between rough and polished surfaces that it is used all over the country as a monumental stone. Pink or red granites, differing from the other types only in the pink color of the feldspar, are also used for both building and monumental purposes. In 1937 there were 21 quarries in operation in the district, many of them having their own finishing plants for the production of dressed stock and completed monuments.

The Lithonia granite is a fine-grained, highly contorted, biotite granite gneiss, used principally for crubing and paving blocks, although some building stone is produced. Some of the waste is used as rubble and crushed, and two large plants are producing crushed stone entirely. The gneissic structure usually does not weaken the granite, which readily splits across the bands of the darker minerals. Eight quarries were operating in the district in 1937.

HISTORY. The first systematic quarrying of granite in Georgia began at Stone Mountain in 1869 and for many years the quarries of the Stone Mountain and Lithonia districts supplied all the granite shipped out of the state. Quarrying began at Elberton in 1891, but only in recent years has the production in this district equalled or surpassed that of the other districts. Large quarries and crushing plants for the exclusive production of aggregate, railroad ballast, and artificial sand are developments of the past ten years.

QUARRYING AND FINISHING METHODS. The quarrying and finishing methods used in Georgia are in general much the same as those used in granite quarries all over the world. In laying out a dimension stone quarry, advantage is taken of approximately vertical joints or fractures, and of nearly horizontal fractures or "sheeting planes." Granite will generally split easiest in one direction, called "rift"; less easily in a direction generally at right angles to the rift, called "grain"; and with greatest difficulty in the third direction generally at right angles to the rift and grain, called "hard way" or "head grain." These considerations must also be taken into account both in laying out the quarry and in splitting up the blocks.

The operations, in brief, consist of making a primary cut or trench for the length of the quarry, wide enough to work in, and as deep as the bench to be worked. Large masses are split off for the length of the quarry; these masses are cut up into large blocks of convenient size to be removed to the mill. The splitting of the granite into the large masses, and then into the blocks, is usually done by drilling a

series of parallel and fairly closely spaced holes and then splitting the rock between them by driving wedges into the holes.

The granite masses of Stone Mountain and Lithonia show a remarkable lack of bottom jointing or sheeting, and a unique method has been developed for making artificial floor breaks.

As used at one Lithonia quarry, two holes of about 3-inch diameter are drilled close together to a depth of about 8 feet. A very small charge of black blasting powder, not more than a spoonful, is placed in each, tamped with clay, and the charges are fired simultaneously with an electric battery. The force of the explosion starts a small fracture running outward from the bottoms of the holes. This process is repeated once or twice a day, gradually increasing the charge of powder, for weeks or even months, thus slowly extending the fracture. The process cannot be hastened without disastrously forcing a vertical or inclined fracture. Solar heat assists the process so materially that it is deemed advisable to suspend operations in the winter. When, in the judgment of the quarryman, the horizontal fracture forms a circle with a 60 to 80-foot radius, an iron pipe is placed in each drill hole, the joint made airtight, and compressed air at a pressure of about 100 pounds per square inch is injected through the pipes to the fracture. The effect is remarkable, for the air pressure immediately widens and extends the fracture until it emerges at the surface of the quarry floor. A sheeting plane thus formed may cover an area of 1 or 2 acres and provide a mass of rock large enough for an entire season's operation.

At the mill the blocks and further split to size by drilling and wedging or are sawed by gang saws. The saws consist of a series of soft steel blades set in parallel position in a frame which has a forward and backward motion. The blades are one-half to five-eights of an inch thick, with notches about a foot apart in the lower edge to carry steel-shot abrasive beneath them, and may be set any desired distance apart. The rate of cutting is four to nine inches an hour. After being roughly shaped up, the sides may be smoothly finished to dimensions by hammering with steel tools by hand or with a pneumatic hammer. Polishing is accomplished with a series of finer and finer abrasives rubbed by hand or machines.

Lettering and the cutting of intricate designs on monuments was formerly done by hand but is now usually done by sandblasting. A polished rock surface is first coated with a molten rubber-like compound, and with a sharp tool the coating is removed from all parts that are to be cut below the surface. Sand or powdered carborundum is forced with compressed air through a nozzle against the

surface thus prepared. Curiously enough the exposed, hard granite is quickly cut away while the sand has little or no effect on the soft, elastic coating. Certain parts of letters or designs may be cut to a depth of one-half to one inch and with a precision and fineness in detail impossible by hand.

The general public often wonders at the high cost of finished granite. This is due mainly to three factors: (1) the hardness of the granite which prevents rapid quarrying and working; (2) the large amount of hand work still necessary in producing a finished monument, for example; and (3) the large amount of waste due to cracks and seams, flaws and imperfections, and to cutting large blocks to irregular shapes. The waste in quarrying and finishing granite may run from 40 to as much as 85 per cent of gross production. Contrary to public opinion, the granite companies are not making excessive profits.

STATISTICS. The value of Georgia's granite production has been over a million dollars per annum since 1921; was $2,730,937 in 1927 and $1,774,754 in 1936. It is surpassed in value only by kaolin, clay products, and marble. In 1935 Georgia ranked second in the United States in the production of monumental granite and fifth in the production of all types of granite.

GRAPHITE

Graphite is a crystalline form of carbon and chemically the same as diamond but far different from it in physical properties. Graphite is one of the softest and blackest of minerals, whereas diamond is the hardest and is usually colorless. Because it was mistaken for lead, graphite is often known as "black lead," and pencils made from graphite are known as lead pencils.

USES. Graphite, as mentioned above, is used in the manufacture of pencil leads. Another important use is in the manufacture of graphite crucibles used in melting brass and in the manufacture of steel. The softness, greasy feel, and flaky character of graphite render it desirable for lubricating purposes, for which it is usually mixed with oil. Graphite paints are largely used to cover metals.

A very large part of commercial graphite is used for foundry facing. For this the cheaper and less pure varieties are employed. In the electrical industry graphite is utilized in dynamo brushes, electrodes, dry batteries and other products, because of its high conductivity. Graphite is also employed in the manufacture of stove polish, glazing powder, and for a great variety of other minor uses.

LOCATION. Graphite in limited quantities is found in a large number of counties in the Piedmont Plateau. The most noted occurrences are in Bartow, Cobb, Pickens, and Madison counties. It is also known to occur in Cherokee, Douglas, Elbert, Hall, Heard, Rabun, Habersham, Paulding and other counties.

GEOLOGY. Graphitic schists, generally of rather low graphite content, are common in some sections of the crystalline area of Georgia, particularly in Bartow, Cherokee, and Pickens counties. Associated with them at places are small irregular veins of purer graphite. The graphite of the graphitic scists is in the form known to the trade as "amorphous" graphite, which means that it is in a finely divided form. Some of the graphite of the irregular veins is in coarser flakes, and is known as "flake" graphite.

The origin of the graphite in these schists and veins is rather obscure. The graphitic schists are thought to represent original sedimentary beds that contained carbonaceous matter derived from either vegetable or animal matter. This carbonaceous matter was changed to graphite by metamorphism, or alteration by heat and pressure during the periods of mountain building that were described in the section on the granites of Georgia. The presence of the purer vein deposits is harder to explain. Some think that they may represent former beds of plant or animal accumulations, others that the carbon was derived by hot mineralized waters attacking and decomposing a limestone deposit, transporting the carbon for some distance, and then depositing it in veins as they cooled off.

HISTORY. Graphitic schists were mined for a number of years near Emerson, in Bartow County, for use as a fertilizer filler. Several irregular veins in this belt of graphitic schist in Bartow, Pickens, and Cherokee counties have been prospected but no production is reported.

A vein of flake graphite on the north side of Broad River, about eight miles northeast of Danielsville in Madison County, is said to have first been worked to a limited extent in slavery times. Between 1924 and 1929, several carloads of graphite were shipped from there, but the deposit has not been worked in recent years.

The Southern Mining and Milling Company of Clarkesville, in Habersham County, has for several years been recovering kyanite and mica from a kyanite-mica-graphite schist. (See description in section on kyanite.) Late in 1937 this company began recovering the small amount of graphite in this schist by floatation, a method of adding a small amount of oil to a water suspension of the finely-ground

material and blowing air through it. The graphite, but not the mica and kyanite, sticks to the froth thus formed and floats over the top of the machine.

IRON ORES

All varieties of iron ores are found in Georgia. Hematite, ferric oxide, Fe_2O_3; limonite, brown hematite, $2Fe_2O_3.3H_2O$; magnetite, FeO. Fe_2O_3 are frequently encountered in the Crystalline Belt. Hematite may be recognized by its red streak; limotite by its yellow streak; magnetite by its black streak and magnetism. In the Valley and

IRON ORE—*Brown iron ore mine in Bartow County with steam shovel digging ore from the earth.*

Ridge Province of northwest Georgia, the two ores of iron are limonite and the red or fossil iron ore. The latter is a variety of hematite.

Brown Iron Ore

Brown iron ore is widely distributed throughout the state, but the principal commercial deposits seem to be confined to the Appalachian Valley and the Piedmont Plateau. The most important deposits, so far discovered, are in the Valley and Ridge Province, occurring in Polk, Bartow, and Floyd counties. In Polk County, deposits occur near Cedartown, Fish Creek, Wray, Esom Hill, Etna Valley, and Aragon. In Bartow County, the most important de-

posits are in the eastern part of the county. The deposits begin about two miles south of Emerson and extend northward for a distance of about sixteen miles to Sugar Hill. In Floyd County, brown hematite occurs near Cave Springs and Silver Creek. Deposits of brown hematite have been worked also in Murray, Gordon, and other counties in the northwestern part of the state. These ores have not been extensively developed in the Piedmont Plateau; there, the deposits are widely distributed and are sometimes associated with manganse ores. Deposits are known in Cherokee, Pickens, Gilmer, Fannin, and Meriwether counties.

GEOLOGY. In the Valley and Ridge Province the brown ores are found with quartzites, dolomites, and limestones of the Paleozoic age. Near Pickens, Gilmer, and Fannin counties, they are found with marble.

Brown ores occur chiefly in pockets, lenses, or irregularly shaped deposits in clay. The deposits vary greatly in size; they vary also in the quality and quantity of the ores. Some of the deposits near Cedartown were worked for more than twenty years without exhausting the supply of ore.

HISTORY. The iron industry of the United States began with the utilization of the brown iron ores. The first iron furnaces in Georgia used these ores which were smelted locally in charcoal furnaces. Spots where charcoal was produced for the old furnaces may still be seen in many places. No more iron is smelted in this manner today. Some ore is shipped to Birmingham but high freight rates to furnaces outside of the state are an important cause for small production of ore at the present time.

FOSSIL IRON ORE

Fossil iron ores are varieties of hematite occurring in beds up to many feet in thickness. Fossil sea shells are abundant in them, hence the name.

LOCATION. Red fossil ores are found in northwest Georgia in Dade, Walker, Catoosa, and Chattooga counties. In Dade County these ores are found in Lookout Valley and Johnson's Creek. In Walker County the iron ores crop out along the eastern side of Lookout Mountain, from the Georgia-Tennessee line to the head of McLamore Cove. From this point the line of outcrop turns sharply to the northeast where it continues for about twelve miles along the westward foothills of Pigeon and Lookout mountains and through

the westward part of Walker and Chattooga counties to the Alabama line, a short distance south of Menlo. Thus there is here a total length of outcropping hematite beds of about 70 miles. Other occurrences are also known. The aggregate length of the beds, more than two feet in thickness, is approximately 175 miles.

GEOLOGY. These ores are of the same age, origin, and general character as the ores of the Birmingham district of Alabama. They were formed in the sea during the Silurian period of the Paleozoic era. At that time a great sea extended over the western part of Gorgia; beds rich in iron were laid down in the sea to be covered later by thousands of feet of other rock. At the close of the Paleozoic time, all the rocks of northwest Georgia were folded and uplifted. Since then, rains and rivers have worn down this region for thousands of feet; thus, the upturned and tilted edges of the beds of fossil iron ores,

Plant in which three products are recovered, graphite, kyanite, and mica ore. The round mullers grind the stone containing the minerals.

limestone, sandstones, and shales are frequently exposed. The red fossil iron ores of Georgia constitute a considerable reserve for the future.

KYANITE

Kyanite, sillimanite, and andalusite are three minerals with the same chemical composition, aluminum silicate, but are quite different in appearance, crystal structure and physical properties, and are ex-

cellent examples of applied research. During the World War the ceramists of the U. S. Bureau of Standards were given the problem of developing a better spark plug core for aeroplane motors. Through research they discovered that the addition of aluminum silicate to spark plug cores resulted in greatly improved mechanical strength and heat resistance. The officials of one company manufacturing spark plugs began to search for a natural aluminum silicate to replace the expensive product. Numerous deposits of kyanite were found, but although it worked well in high-heat duty firebrick, it would not do for spark plug cores because at a certain temperature it changed its crystal form with a change in volume that warped the cores. After a long search a commercial deposit of sillimanite was found high in the mountains of California and is today used in their product and featured in their advertising literature. The by-product of this research is the use today of kyanite in high-heat duty of refractories and other ceramic products.

LOCATION. Kyanite, in the form of large scattered boulders and as a minor constituent of mica schists, is fairly common in many counties in the crystalline area of north Georgia. The most important deposits, however, are in a U-shaped belt, some 30 miles in length and from 100 feet to a quarter of a mile in width, in Habersham and Rabun counties.

GEOLOGY. Kyanite is generally found associated with metamorphic rocks. The larger boulders of massive kyanite found on the surface at a number of localities represent the surface accumulation from small veins or lens-shaped masses not more than one or two feet thick, and with a horizontal extent of not more than a few feet. They probably represent an extraction and redeposition of alumina and silica by ascending hot waters. The kyanite-mica schists, on the other hand, are probably formed by the metamorphism or alteration by heat and pressure of sedimentary beds rich in alumina.

The belt of kyanite-bearing schist in Habersham and Rabun counties described above is composed of quartz grains; flakes of muscovite mica; flat kyanite crystals averaging one inch in length, ½ inch in breadth, and ¼ inch in thickness; and little graphite. No sharp boundary can be distinguished between the kyanite schists and the adjoining rocks, and in the schists richest in kyanite the crystals are remarkably well concealed. The kyanite crystals are not uniformly distributed through the schist, beds a few inches thick and crowded with crystals alternating with beds of equal thickness where the crystals are more sparsely distributed. The amount of kyanite ranges

from 1 to 15 per cent, with a general average of 6 to 8 per cent at places favorable for mining.

The outcrop of the kyanite schist is marked by a surface accumulation of kyanite crystals left behind as the mica and sand were washed away. At places erosion has transported the kyanite crystals into the valleys of the present and former streams, where they form placer deposits of commercial importance.

HISTORY. The kyanite industry of Georgia is largely due to the initiative of one man, Mr. Philip S. Hoyt of the Southern Mining and Milling Company (formerly the Georgia-Carolina Minerals Corporation) of Clarksville, Georgia. About 1930 Mr. Hoyt, who had mined nonmetals in the west and southwest, searched the southern Appalachians for mineral deposits that could be developed. At two places northwest of Clarksville in Habersham County he found surface accumulations of loose kyanite crystals from a kyanite-mica schist, and in 1932 started mining and washing the kyanite crystals from one of these. In 1934 he also began recovering kyanite from a placer deposit where the kyanite crystals had accumulated in the valley of a small stream that headed on a kyanite mica schist deposit.

The United State Geological Survey in 1934, at the request of and in co-operation with the Georgia Geological Survey, made a thorough investigation of the deposits and found that the two known areas of kyanite-mica schist in Habersham County were but a part of the U-shaped belt of schist described above, and that the reserves of kyanite in this area are enormous. Mining of the partly weathered kyanite schist itself began in 1936 and has slowly increased as methods were worked out for the recovery of the kyanite and the by-products of ground mica and graphite. The kyanite is largely going into the manufacture of glass tank blocks.

MINING AND MILLING METHODS. The kyanite-mica schist is mined by pick and shovel methods that enable a certain amount of selection of the beds richest in kyanite, and it is hauled to the mills in trucks. After a preliminary crushing and screening, the disintegration of the schist and the separation of the kyanite, mica, and sand are largely accomplished in mullers, consisting of two large solid wooden wheels, faced with old rubber truck tires, that travel around a wooden tub with center overflow. The action of these wheels traveling over the schist under water flakes off the mica and cleans the kyanite crystals. Further washing, screening, jigging, and tabling on shaking tables separate the kyanite, quartz sand, and mica. The graphite is recovered by floatation. (See section on graphite.) The

kyanite is ground to the sizes desired by the consumer. About three tons of ground mica and 100 pounds of graphite are recovered for every ton of kyanite produced. The quartz sand is at present discarded.

STATISTICS. No figures are available on the annual production of kyanite in Georgia. The capacity of the three kyanite mills of the Southern Mining and Milling Company, if operated full time, is about 25 tons of kyanite per day.

LIMESTONE

LOCATION. Limestones are found in three main geographic regions of Georgia: the Coastal Plain, the Piedmont, and the Paleozoic areas. In the Coastal Plain, limestones accur in many counties but are of economic importance only at certain localities. In the Piedmont area, the limestones have been altered to marbles and will be described under that heading.

Limestones of the Paleozoic area are most abundant and of great importance. They occur in Polk, Floyd, Bartow, Chattooga, Gordon, Walker, Dade, Catoosa, Whitfield and Murray counties.

GEOLOGY. Limestones occur at various horizons in the sediments of the Coastal Plain. Perhaps the most important one is the limestone mined in Houston and Bleckley counties, known as the Ocala limestone.

It is thin-bedded, soft, light-gray to white in color, and contains fossils of a great many marine shells and organisms, along with considerable quantities of clay. The limestones of the Paleozois area are generally dense, hard, semicrystalline and evenly bedded. They may be either of organic or inorganic origin.

HISTORY. History of the lime industry of Georgia extends back to the earliest settlers. It has long been recognized that the beginning of limestone production came with the discovery that its application enriched the soil. Thus limestones were first used for agricultural purposes, and in mortar for building purposes. The limestone industry in Georgia has only recently reached a relatively important degree of value.

The term "limestone" is used in a very general sense. It includes unconsolidated and also consolidated rocks largely made of calcium carbonate with varying amounts of silica, alumina, iron oxide, and the alkalies. When the rock contains a high percentage of magnesium carbonate, it is known as dolomite.

Probably no other rock is used for such a variety of purposes as limestone. It is used for lime in building, for paving, curbing, flagging, mortar, rubber, riprap, railroad ballast, and road building. When ground, it is used for concrete, furnace flux, fertilizer, and natural and Portland cements.

MANGANESE

The manganese ores of Georgia are black manganese oxides which in some sections contain more or less brown hematite or limonite.

LOCATION. Manganese deposits are widely distributed over the state. They occur in the northern part of the state in the Crystalline Belt and Appalachian Provinces. The oldest and the largest producing manganese mining district is the Cartersville area. The second producing district of the state is in the vicinity of Cave Springs. Other manganese prducing locations in the state are the Draketown, Tunnel Hill, Varnell-Cohutta, and Doogan Mountain districts. Manganese has also been produced from many isolated deposits.

GEOLOGY. Manganese ores are found associated with two types of rocks. In the Crystalline Belt of the state, they occur in bodies elongated usually in a northeast-southwest direction. These bodies are enclosed by slates and other types of metamorphic rocks. In the great valley region west of the crystalling rocks, the deposits occur in quartzite, limestones, dolomites, and marbles. They generally form in clay over quartzite or limestone.

MINING AND USES. Manganese was first mined in Georgia about 1866 and most of the manganese ore produced in the state has come from the Cartersville district. The total production of manganese ore from this district is well over 100,000 tons.

Manganese is mined in open cuts and pits, shafts and tunnels, depending upon the accessibility of the ore.

Although mined for many years, manganese ore is still an important mineral resource of Georgia. It is very scarce in most other parts of the United States, so that most of the manganese used in the United States is imported from foreign lands.

Thousands of tons of manganese are used annually in this country for the production of dry cell batteries. It is used to tint glass a lavender color; it has wide uses in the chemical trade in the manufacture of chlorine, oxygen, and other products. The greatest use of manganese is as an alloy with steel. Manganese steel is essential to industry.

CHAPTER VII

MARBLE

Marble is generally defined as a crystalline limestone susceptible of taking a polish. True marble is usually a product of recrystallization due to alteration or metamorphism by heat and pressure of mountain building forces. It may be relatively pure calcium carbonate or a mixture of calcium and magnesium carbonates (dolomitic.) Also classed with marble by the trade are Mexican or cave onyx and verd antique. Mexican or cave onyx is a chemical precipitate of calcium carbonate from cold-water calcareous springs. Usually it shows highly ornamental banding. Verd antique or "green marble" is composed mostly of serpentine and is a metamorphosed igneous rock. It may contain little or no calcium carbonate but it takes a good polish and is used in the same way as the true marbles.

USES. Marble is used mainly for buildings and monuments, interior decoration, statuary, and novelties.

In exterior building marbles and monumental work, qualities of endurance rank equally in importance with appearance. For such outdoor uses, therefore, marbles should be strong, uniform, close-grained (though not necessarily fine-grained), reasonably nonabsorptive, and free from impurities that may strain or corrode the surface.

For interior decoration, appearance is the prime factor determining value. Both pure white and variously colored marbles are applied to many uses, including floors, steps, baseboards, columns, balusters, wall panels, wainscoting, and arches. Verd antique is popular for interior decorative effects and as an exterior oranmental stone, as for example, on banks and store fronts.

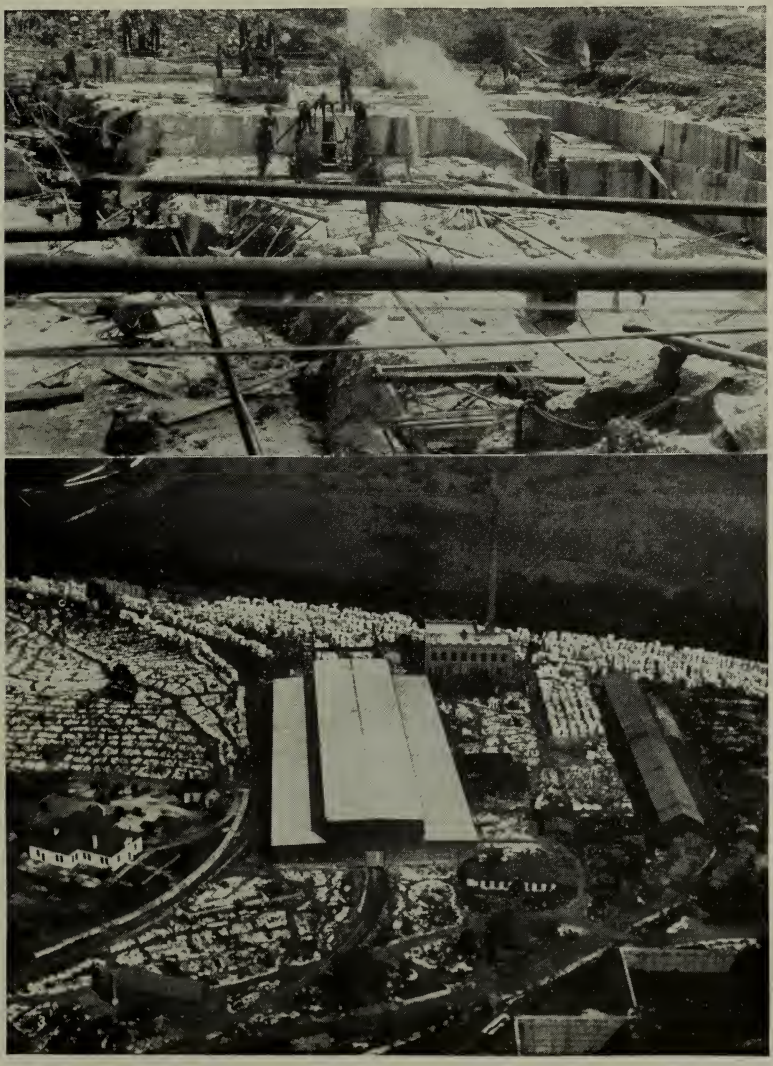
Statuary marble is the most valuable variety quarried. It must be pure white, uniform, usually fine-grained in texture and somewhat translucent, and must have marked adaptability for carving.

Waste marble and that unsuited for building and monumental purposes is converted into crushed stone, terrazzo, stucco, and riprap, and also used for lime, fluxing, and various chemical treatments.

LOCATION. All of the true marbles of Georgia so far worked on a commercial scale occur along the Blue Ridge Branch of the Louisville and Nashville Railroad, in a narrow belt about 60 miles long and from one to three miles wide traversing in a southwesterly direction the counties of Fannin, Gilmer, Pickens and Cherokee. At present typical Georgia marble is quarried only in the vicinity of Tate and

Marble Hill in Pickens County. A fine-grained dolomitic marble not suited for most building and monumental purposes is quarried near Whitestone on the Pickens-Gilmer county line and is crushed and ground for various uses. Somewhat similar dolomitic marbles are found in limited quantities in Stevens, Habersham and Hall counties.

Fine-grained crystalline limestones that would take a polish and would therefore be classed by the trade as marble are found at a num-



MARBLE—*Above—Quarrying the famous Georgia marble in Pickens County. Below—View of a marble mill sawing and finishing marble blocks.*

ber of localities in the Paleozoic area of northwest Georgia. They occur in a wide variety of colors including solid black, but are usually thin-bedded and cannot be quarried in large blocks. An attempt was made to quarry a marble of this type several years ago near Summerville, Georgia, but with indifferent success.

Very limited quantities of Mexican or cave onyx are found in caves in northwest Georgia, but no attempt has ever been made to quarry them.

Verd antique or serpentine marble is found in several deposits in the crystalline area of north Georgia but is quarried only near Holly Springs in Cherokee County.

GEOLOGY. The true marbles of Georgia occur near the western margin of what is known as the crystalline area of the state. The rocks associated with the marbles are chiefly of sedimentary origin and have been more or less metamorphosed during the periods of mountain building described in the section on granites. They were formerly thought to be of early Paleozoic age but some geologists now consider them to be still older (Pre-Cambrian).

The 60-mile long marble belt described is by no means wholly made up of marble but contains a number of other rocks. The marble is found in several long outcrops, also called "belts," of which the most important is the Tate Marble Hill belt. The Tate portion of this belt begins about a mile south of Tate and extends northward along Swamp Creek for a total distance of about two and three-quarters miles. It is approximately a mile wide at Tate but narrows at each end. The Marble Hill portion of the belt branches off just east of Tate and swings northward and then eastward past Marble Hill, with a total length of nearly five miles and a maximum width of half a mile. The beds are steeply dipping and extend to unknown depths. The quantity of commercial marble available is inexhaustable.

The principal colors and textures of the marbles quarried are described below:

GEORGIA WHITE. A coarse-grained calcite marble of almost pure white color with a sparkling luster. It is marked here and there by vague streaks of grayish-blue tone which, however, are not distinct enough to do more than break the monotony of a solid color. Because of its uniform grain, translucency and soft white color it is a favorite stone for buildings, ornamental structures, monuments, and statuary. It was the stone used for the statue of Lincoln in the Lincoln Memorial at Washington, D. C. The Georgia marble is now quarried in

the New York Quarry at Marble Hill but in the past it has also been quarried at the Amicalola and Cowart quarries near Marble Hill.

CHEROKEE. The Cherokee or Silver Gray marble, from the Cherokee Quarry near Tate post office, is a corase-grained grayish-white marble that differs from the Georgia White in possessing a grayish tone and a remarkable degree of translucency. Moreover, it is marked by a few light-gray and dark-gray streaks that are curved into designs that grade off into cloudlike masses of a very light-gray color. The variety is free from streaks. Although used for both exteriors and interiors of buildings, it is especially desired by sculptors for large groups and is a favorite monumental stone.

CREOLE. The Creole type of marble is a mottled dark-gray and white rock known as light Creole when the dark mottling is subordinate and as dark Creole when more prominent. The dark streaks may be straight or curved or they may be interwoven into intricate patterns. It is a little finer grained than most of the other varieties. The Creole marble has been popular for gravestones but is not used for this purpose as extensively as heretofore. It is employed as a trim with the Georgia White and Silver Gray marbles on large buildings, and also as an interior finish of corridors, etc., in public buildings. Because of its distinct veining the Creole marble is beautifully adapted to the production of excellent effects in matched panels such as those on display in the State Museum on the fourth floor of the Georgia State Capitol. It comes from the Creole quarries a few rods southwest of Tate post office.

MEZZOTINT. The Mezzotint variety is intermediate between Silver Gray and Light Creole both in tone and texture but is distinguished by blotches of a light purplish-gray color. It is much used for interior work and is also employed in large buildings where the nearly pure white of the Georgia White marble is not desired. The quarries are immediately east of the main Cherokee Quarry near Tate post office.

ROSEPIA. The Rosepia marble from a quarry near Marble Hill, is the finest-grained and most magnesian marble quarried in this district. It is a white stone marked by amber streaks and scattered amber spots. The general effect at a little distance is that of a very light pink marble crossed by irregular streaks of a little deeper pink. It is generally used for interior decoration.

ETOWAH. The Etowah or pink marble is the product of the quarry of the same name situated near Tate post office. This marble

varies in color from old rose to deep pink. It is crossed by greenish-black veins and is mottled with greenish-black and gray splotches, some of which are speckled with black dots, but blocks of a uniform pink color may be obtained by careful selection. It is a little finer grained than the Cherokee variety. The Etowah marble is especially favored for interior work, for the trim of buildings faced with Georgia White marble, for the construction of ornamental public buildings and sumptuous private residences, and for decorative structures, such as public fountains, etc.

The fine-grained white magnesium marble of the Whitestone belt is not used for dimension stone, but is quarried on the Pickens-Gilmer county line near Whitestone and is crushed for aggregate, road material, terrazzo chips, etc., ground for agricultural lime and for numerous chemical uses.

HISTORY. The first systematic quarrying of marble in Georgia began in 1840 by Fritz T. Simmons near Tate in Pickens County. Tombstones were first produced entirely by hand labor, but after two years he erected a mill with one gang of saws near Marble Hill and later one on Longswampy Creek two miles east of Jasper. In 1850, Tate Adkinson and Company opened a quarry near the present site of the Georgia Marble Company and erected two mills, each with two gangs of saws. With this increased production the firm found it necessary to employ an agent to travel through north Georgia soliciting tombstone orders which were later delivered by a 6-mule team. After two years the company was succeeded by Rankin, Summy and Hurlick who later also operated a quarry and mill east of Jasper. The Civil War brought an end to these operations and very little marble was quarried during the succeeding twenty years.

An interesting story is told that in 1883 or 1884 when plans were being made for the erection of the present State Capitol in Atlanta, a committee of the Legislature was sent to Pickens County to see if there was sufficient marble there with which to erect the building. Seeing only one small quarry producing tombstones, they reported that there was not marble enough in Georgia for such a magnificent building, but that they thought there might be enough to use for flooring the lobbies and corridors. So Georgia's capitol was built of Indiana limestone instead of her own marble which has since been used for thousands of magnificent buildings, including several state capitols.

The organization of the Georgia Marble Company in May, 1884, marks the beginning of a very important epoch in the history of the

marble industry in Georgia. Previous to this time Georgia marble was practically unknown to the trade as a building stone and had only very local use for tombstones, etc. At a cost of nearly a million dollars new quarries were opened, mills erected, and a private railroad built to the present Louisville and Nashville Railroad at Tate. With modern methods of quarrying and finishing and an efficient sales force, Georgia marble began to be used in increasing quantities throughout the country and abroad for building, ornamental and monumental purposes. Other companies sprang up and flourished for awhile, but have all been absorbed by the Georgia Marble Company which is now the only producer of the true Georgia marble.

QUARRYING AND FINISHING METHODS. The methods of quarrying and finishing Georgia marble are very similar to those used in Georgia's granite industries described in the chapter on granite. The main cuts made in separating the marble into blocks for lifting from the quarry are usually made by channeling machines. These may be described as mechanically operated drills, working on a track on the quarry floor. They cut a groove about 2 inches wide across the length of the quarry floor to the depth the bench is to be worked.

The quarries at Marble Hill are usually sidehill quarries, whereas those at Tate are pit quarries. An underground operation has recently been started at Tate to quarry under a hill with heavy overburden. The pit quarries are usually 100 feet in width and 100 to 250 feet in length. Their depth ranges from 100 to 200 feet. The good marble goes much deeper, but when the cost of hoisting the blocks to the surface becomes excessive it is cheaper to open up a new quarry beside the old one, leaving a ten to fifteen foot wall between to keep out the water that fills up the abandoned quarry.

Modern and well equipped finishing plants are located at Tate, Marble Hill, Ball Ground, Nelson, Canton and Marietta.

STATISTICS. The value of the annual production of Georgia marble has varied, depending on the prosperity of the building industry, from one to two and a half million dollars.

MARLS

LOCATION. The marls of Georgia are confined to the Coastal Plain section and are widely distributed. Good exposures may be found along the Chattahoochee, Flint, and Savannah rivers. Good exposures are also to be seen along the Alapaha in Echols County, the Big Satilla in Camden, and along the Altamaha in Wayne County.

In addition to these outcrops, marls in less extensive beds are frequently found along smaller streams throughout the Coastal Plain.

GEOLOGY. The most extensive and probably the best deposits of marl are the so-called glauconite or greensand marls which occur in the Cretaceous and Eocene formations. Beds of marl occur also in the Oligocene, Miocene, and Pliocene formations. Marls are especially well developed in the Miocene along the Savannah River in Effingham and Screven counties, and along the Altamaha River in Wayne County. Generally, the marls occur as even but thinly bedded strata which in some places grade into limestone. The marls may also grade into sand, depending upon conditions of sedimentation at the time of their deposition. For the most part, the marls are of marine origin and usually contain fossils.

DESCRIPTION OF MATERIAL AND USES. The term "marl" means a calcareous clay or clayey sand which carries a small percentage of phosphoric acid or potash. When the calcareous material is in the form of broken shells, it is known as shell marl; and when the mineral glauconite (a hydrated potassium iron silicate) is present in considerable abundance, it is often called a greensand marl.

Marl is usually soft and earthy and can be mined with pick and shovel. It varies in color but generally is gray, greenish gray or almost black.

Marl is used chiefly as a fertilizer. Its value for this purpose depends upon the amount of lime, phosphoric acid, and potash present. The chief agricultural constituent of marl is always lime carbonate which acts in a beneficial way on stiff clay soils and others deficient in lime.

Besides the agricultural use, marl can be used in the manufacture of Portland cement, when it is pure enough.

MICA

Mica, or isinglass, is one of the best known and most abundant minerals of the Crystalline Belt of Georgia. Two kinds of mica are common. Black mica, or biotite, is abundant in many places in small or large flakes scattered through practically any kind of rock. Muscovite, the commercial variety, is nearly colorless or transparent. It varies in size from tiny flakes to large blocks or books with leaves over a foot across. These blocks may be split to any thickness, the leaves being flexible and elastic.

LOCATION. All counties in the Crystalline Belt of Georgia contain varying quantities of mica. It has been either mined or pros-

pected in Upson, Monroe, Pickens, Cherokee, Jackson, Hall, Lumpkin, Union, and Rabun counties. It has been mined in Lumpkin and Union counties near the Lumpkin-Union line about twelve miles north of Dahlonega; in Rabun County at the Kell Mine, ten miles east of Clayton; in Hall County near Gainesville. During the World War, it was extensively mined in Upson, Monroe. Cherokee, Pickens, and other counties.

GEOLOGY. Mica is found in nearly all varieties of metamorphic and igneous rocks. Tiny flakes may be seen in practically any granite. Soils in Georgia aften sparkle in the sunlight as the light is reflected

MICA—(*Known also as isinglass*). *Mica mine entrance near Dahlonega.*

from millions of flakes of mica. Sheet mica of commerce is found in very coarse-grained granites called "giant granites" or pegmatites. In such granites, mica and feldspar crystals grow to great size.

MINING AND USES. Sheet mica sells according to size, clearness, and freedom from impurities. It is trimmed into sheets of various sizes. Most of it is used for electrical insulation purposes in connection with heaters, electric irons, toasters, etc. Small sheets are used as disks and washers in lamp sockets, fuses, radio tubes, etc.

Fine mica flakes are mined from weathered rock near Clarkesville in Habersham County. Kyanite and mica are separated in water from the other impurities of the rock.

Ground mica is used in wallpaper and some paints, and is used to some extent as a filler in rubber, but most ground mica goes into

the manufacture of roofing. Clear flakes of mica are the "snow" used on Christmas trees. It has a wide variety of uses. Mica deposits of Georgia are quite undeveloped.

OCHER

Red and yellow ocher is common in Georgia. Red ocher is a very fine powdery variety of hematite; whereas, the yellow variety is a very fine powdery type of limonite or "brown hematite."

Ocher deposits have been worked for a very long time in Bartow County near Cartersville, where they are found in a belt extending nearly north and south for about eight miles. The belt begins at a point about two miles south of the Etowah River, extends northwest, passing about one mile east of Cartersville, and terminates at a point north and to the west of Rowland Springs. Deposits probably also occur in other localities.

Ocher occurs in quartzite and residual clays where it has formed through the processes of weathering. It was mined in Bartow County as far back as 1877.

The yellow and the dark umber ochers constitute the varieties most frequently minded. Most of the Georgia ocher mined today goes into the manufacture of linoleum.

OLIVINE

Olivine is a magnesium-iron silicate, olive-green in color, found chiefly in ultrabasic igneous rocks such as dunite and in veins or dikes cutting such rocks. In recent years olivine has come into a limited use as a refractory, particularly in lining basic open-hearth furnaces in the steel industry. For this use it may be shaped into blocks, or ground and made into firebrick. North Carolina is the principal producer.

Deposits of olivine are known to exist in the crystalline area of North Georgia, but have never been thoroughly prospected. A limited market for olivine exists in the Birmingham district of Alabama and could be supplied more cheaply from Georgia than from North Carolina if deposits of sufficient size and purity should be found.

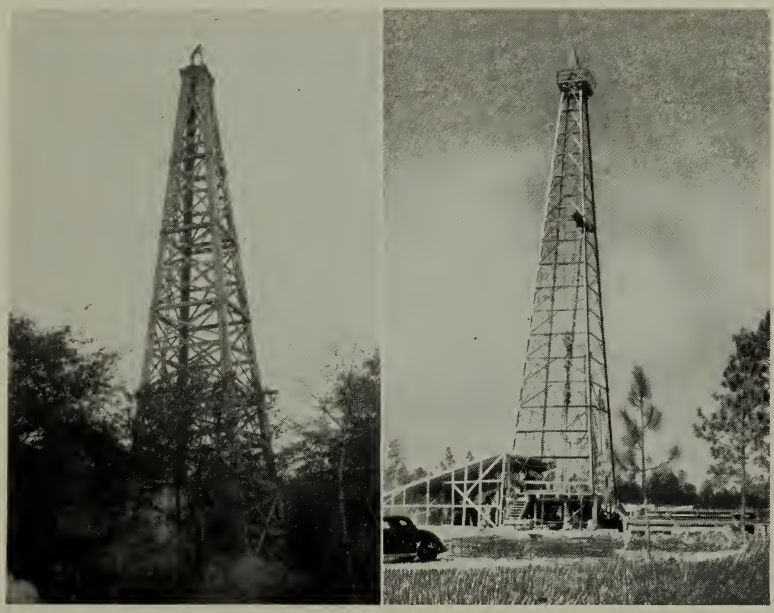
CHAPTER VIII

Petroleum and Natural Gas

Location. Nearly all prospecting for petroleum and natural gas has taken place in the Coastal Plain section of Georgia. A few ill-advised attempts to locate these minerals were made in the Piedmont

section and a few wells, on better advice, were spotted in the northwest Paleozoic area. Oil and gas prospect wells have been drilled in many places in South Georgia but all have been unsuccessful up to the present (May, 1938).

GEOLOGY. Some type of structure is necessary for the accumulation of oil and gas. Generally beds of relatively high porosity overlain by impermeable beds are bowed up into anticlines or domes, which are merely rock folds. Oftentimes oil and gas accumulation takes place because of the faults or fissures that are present and so situated that they act as traps. Again porous beds, laterally grading



OIL WELLS—*Left—Old type tower used in digging an oil prospecting well at McRae, Ga. Right—Modern, rotary equipped oil test well in Pierce County, Ga.*

into nonporous beds, both being capped by an impermeable material, may also serve as oil or gas traps. Beds in which oil and gas are found, irrespective of their lithology, are termed in the driller's parlance, as "sands." Thus a producing horizon may be a limestone but it is nevertheless referred to as a "sand."

Naturally when an oil-bearing horizon is tapped by the drill, gas or water pressure will force the oil from the sand into the well. The production of oil is therefore intimately related to the pressure and

amount of gas present in the sand as well as to the water content; consequently, it is not only a good conservation policy to preserve gas in the sand but it is also good business. No gas should be permitted to escape from a well merely to obtain a high yield, for recent studies have shown that when the gas is dissipated, only a fraction of the total oil is recovered.

HISTORY. Oil and gas seeps have long been known in Telfair and Pulaski counties. Both seeps are closely related to springs issuing from Miocene sands and clays, but their importance as good indicators of the presence of commercial quantities of oil and gas is questionable. Wells drilled in their immediate vicinity were barren of production, although "shows" of gas and oil were reported.

A well at Scotland, Georgia, was drilled by the Dixie Oil Company, to a depth of 3,384 feet and ended in hard sandstone. Another well, drilled somewhat to the southeast of Town Bluff Ferry ,in Jeff Davis County, reached a depth of 1,105 feet. Both of these wells were dry holes although near the seeps.

Several other wells, drilled for oil and gas, were located near Friedel, Ware County; near Graymont, Emanuel County; and near Savannah, Chatham County. The entire area is covered by Miocene sands and gravel to so great an extent that little or no satisfactory surface geology can be known. Consequently locations made without the help of modern instruments have little value in that section.

In 1937, modern methods were introduced and mapping proceeded from the Florida line northwestward into South Carolina. Detailed prospecting was done with the magnetometer and the seismograph. Several locations were made from the information so obtained and a test well was begun near Offerman, in Pierce County, in 1938.

DESCRIPTION OF MINERAL. Petroleum has no definite chemical composition but is formed of a series of hydrocarbon compounds. Natural gas is generally composed of the chemical compound methane which is also known as marsh gas. Petroleum may vary in color from black to green, and yellow, and may be a colorless substance. It is generally liquid, although its viscosity may make it appear as a solid in some cases and as a gas at other times, depending upon temperature, pressure, and other physical conditions.

Some petroleums have a paraffin base, others have asphaltic bases, while still others are a mixture of both. As a rule oil has some odor but not always. Usually petroleum will float on water because it is lighter in weight. When oil is spread out in a thin film it will produce a rainbow or iridescence. Methane has a flat but sweetish odor when

pure, but the presence of sulphur may give the gas an odor like rotten eggs. Methane is colorless and very inflammable.

The origin of petroleum is a very disputed subject. Geologists generally agree that it is the result of a distillation of ancient plant remains which were buried in the sediments in which the oil is found today. Probably the oil and gas have not migrated to their present locations from a great distance.

USES. By far and large the greatest use for oil and gas is heating and combustion. However, literally thousands of different substances for use in many industries are made from petroleum refinery by-products.

If oil is found in Georgia, the economic benefits are too important to visualize. Every effort should be bent towards this goal for it is undoubtedly the second most valuable mineral resource in the world, being exceeded only by water.

POTASH-BEARING SLATES AND SCHISTS

Slates containing 7 to 10 per cent potash occur north of Cartersville, Bartow County, in a belt 15 miles long and one to four miles wide. The best exposures are near White on the Louisville and Nashville Railroad, where a thickness of several hundred feet of such material is exposed. The sericite schists found several miles southwest of Jasper, Pickens County (See section on sericite.), also contain about the same amount of potash. In both cases the potash is in the form of insoluble silicates and is not available as a plant food.

A process for extracting the potash from these slates and schists by calcining them in a cement kiln was worked out during the World War when our supplies of potash from Germany were cut off, but at the present it cannot compete with the imported potash or that from the soluble potash deposits discovered a few years ago in the southwest.

PRECIOUS STONES

A large variety of minerals suitable for gems and other ornamental objects and cabinet specimens have been found in Georgia. No systematic mining for gems, however, has been carried on and the finds have been accidental, or incidental to gold, corundum, and other mining. Only the most important will be described below.

DIAMONDS. A number of diamonds have been reported from Georgia at various times, many of them from the early gold placer

operations. Some of these reported finds may not be authentic, but some of them are and gems have been cut from them. In no case have they been found at their point of origin and their source remains obscure. One or more diamonds have been reported from the following counties: Hall, White, Habersham, Banks, Lumpkin, Dawson, Forsyth, Gwinnett, Cherokee, Clayton, Bartow, Haralson, Carroll, Paulding, Cobb, and Twiggs.

RUBY AND SAPPHIRE. Ruby and sapphire are corundum gems. (See section on corundum.) While no very fine gem material has yet been discovered in Georgia, some have been cut *en cabochon* (rounded) for use as a semiprecious stone. The name "ruby" is applied to crystals of gem corundum of some shade of red to "sapphire" blue and other colors, and also to transparent, colorless crystals. Imperfect rubies have been found in Towns, Habersham, and Paulding counties, and sapphires in Rabun, Walton, and Paulding counties. The ruby corundum shows a beautiful dark-red fluorescence when exposed to ultraviolet rays.

QUARTZ. Clear, transparent quartz of the variety known as "rock crystal" is found at many places in north Georgia but usually is small crystals, often having crystal faces and terminations. Some pieces are large enough for cutting crystal beads, once popular but now widely imitated in glass. Smoky quartz, rutilated quartz (containing minute needles of rutile), and rose quartz suitable for cutting *en cabochon* or in beads are also found at several places. A noted locality for rose quartz is the old Kell Mica Mine in Rabun County. The rock is a light-rose color that fades somewhat on exposure to light but it has a chatoyancy that makes it attractive for cutting and polishing.

Amethyst is a violet or purple variety of crystalline quartz that at times is popular for cut stones. Rabun County has furnished some of the finest amethysts obtained in this country but no systematic search for them has been instituted. Quartz containing tinges of amethyst color is common in the crystalline rocks of north Georgia but only rarely are crystals suitable for cutting into gems found.

CHALCEDON, AGATE, AND JASPER. Amorphus or cryptocrystalline forms of silica, sometimes called "noncrystalline quartz," are found at a number of places in the state in colors that make them suitable for cutting and polishing as semiprecious stones. Notable examples are a banded red, yellow, brown, and white agate near Kingston in Bartow County; moss agate at the "Rock House," a cave

near Cordele, Crisp County; banded agate near Roundoak, Jones County; the State Prison Farm, Baldwin County, and Wilmot's Ravine near Thomaston, Upson County; and reddish jasper near Roundoak, Jones County, and along the Flint River near Albany, Dougherty County.

BERYL. The common beryl has been found in old mica mines at a number of localities in the state, but is rarely of gem value. A pale-blue crystal from the property of W. T. Smith, Moccasin District, Rabun County, and a pale-green crystal from Captain Buck's farm, eight miles east of Clayton, Rabun County, have sufficient transparency to be of some gem value. No true emeralds of the rich deep-green variety have been found.

GARNET. Almandine, the common iron-alumina garnet, is widely distributed in mica schists and other metamorphic rocks in the crystalline area of the state. It is usually in crystals and is a deep-red color when fresh, but the crystals generally have a rusty coating due to alteration from weathering. Very few Georgia garnets are clear and flawless enough for cutting into gems. A noted locality for collecting large dodecahredral garnet crystals is a hill a short distance west of the Little Bob Pyrite Mine near Hiram, Paulding County.

MOONSTONE. A transluscent variety of feldspar known as moonstone suitable for cutting *en cabochon* is found at several localities in Georgia.

RUTILE. Rutile is an oxide of titanium, usually black or reddish-brown in color, and is sometimes found in twinned crystals and reticulated groups that form natural ornaments. It also exhibits a natural polish, has an adamantine luster and is often cut for gems.. Graves Mountain, Lincoln County, furnishes probably the finest crystals of any locality in the world. Over $20,000 worth of crystals are said to have been sold from this locality for cabinet specimens.

STAUROLITE. Twinned crystals of staurolite in the form of natural crosses, sometimes known as "fairy stones," occur in Fannin and Cherokee counties.

PEARLS. A few valuable pearls have been obtained from the shells of mussels in streams in the northwestern part of the state. The pearls obtained from the oysters along the coast lack luster and are of little or no value.

PYRITE

Pyrite is one of our most common minerals. It occurs in small quantities, usually in the form of cubic crystals, in many kinds of rocks, both igneous and sedimentary, but only occasionally is it found in sufficient quantity and purity to be of commercial value. Most of the commercial supply is derived from mineral veins or replacements deposited by hot solutions given off from masses of intrusive igeous rock. Such ores frequently carry also valuable metals, such as gold, copper, lead and zinc.

Pyrite, or iron pyrites, is a disulphide of iron (FeS_2), containing theoretically 53.46 per cent sulphur and 46.54 per cent iron. Under the trade name "pyrites" are included various other sulphide minerals, especially marcasite or white iron pyrites (FeS_2), pyrrhotite or magnetic pyrites ($Fe_{11}S_{12}$), chalcopyrite or copper pyrites ($CuFeS_2$), and arsenopyrite or arsenical pyrites (FeAsS).

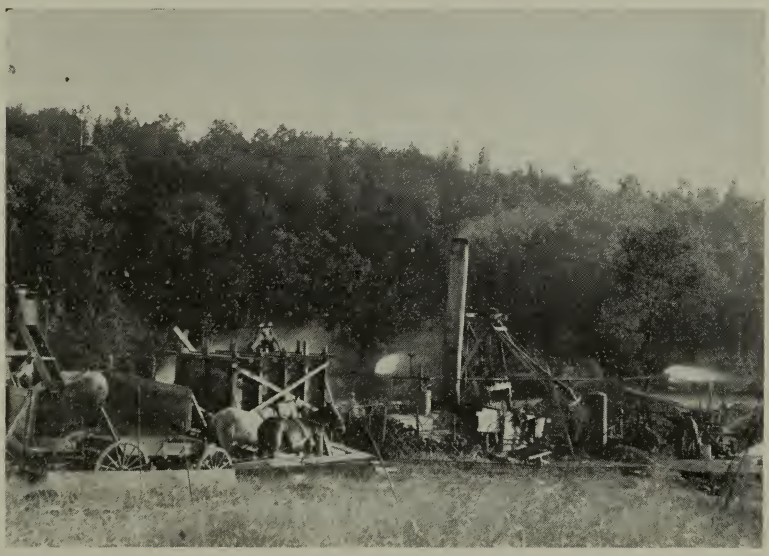
Commercially, pyrites ores are divided into lump ore and fines. The former, as the name suggests, is massive ore broken into lumps a half inch or more in diameter, and carrying sufficient sulphur (about 40 per cent) to be self-burning when heated to the ignition point in a furnace. The fines are in the form of smaller particles resulting from the breaking of the ore in the process of mining or by crushing for the purpose of separating from worthless minerals by some process of concentration. The fines are roasted in specially designed furnaces with methanical agitation during burning, so they cannot be used interchangeably in plants equipped for burning lump ore, and therefore they bring a slightly lower price than the lump.

The percentage of sulphur in the fines depends on the original character of the ore to be concentrated and on the local practice and methods of concentration. Some ores which break readily and concentrate cleanly can be brought to more than 45 per cent sulphur without undue loss of pyrite in the tailings, but with other ores it does not pay to concentrate much more than 40 per cent. Acid manufacturers desire ore of at least 40 per cent grade, and ore that carries less than 35 per cent of sulphur is seldom used. At any mine the desirable ratio of concentration depends on the balance between the cost of shipping an additional amount of worthless material and the value of the pyrite wasted with the tailings. Prices of both fines and lump are always quoted per unit of one per cent sulphur per long ton.

After the sulphur is burned out of the ore the cinder may be treated for the extraction of any gold and copper it contains, or may be

nodulized and used as iron ore. Zinc, copper, and lead in the ore retain a certain amount of sulphur which will therefore not be available for making acid. Arsenic and antimony are carried over into the acid chambers with the sulphur fumes, and these elements are highly undersiable in acid for most uses. Carbonaceous matter, which is not present in pyrites except that from coal beds, produces a dark-colored acid, but this is not objectionable for such uses as fertilizer manufacture.

PRODUCTION AND IMPORTS. Georgia was once one of the leading producers of pyrite for use in the manufacture of sulphuric acid. During the period 1916-1919 there was a considerable revival in the



PYRITES—*Mineral used for making sulphuric acid. Because it resembles gold it is quite commonly called "Fool's Gold." Operation shown above is in Paulding County.*

mining of pyrite in Georgia as a result of the discontinuance of the importation of pyrite from Spain and other foreign countries. However, this activity ceased with the close of the World War and since 1919 there has been practically no production of pyrite in Georgia. In 1916 only two mines reported production. In 1917 five companies—the Standard Pyrite Company, the Georgia Mining Company, the Shirley Mining Company, the Sulphur Mining and Railroad Company, and the Marietta Mining Company—reported

a total production of 23,242 long tons, of which about one-fourth was lump ore. Besides these the Chestatee Pyrites and Chemical Corporation, the Arizona and Georgia Development Company, and the Southern Pyrites Ore Company were producers in 1917-18.

USES. The only important use of pyrite is in the manufacture of sulphuric acid. This compound is used in almost all the industries, and its production and price next after iron and steel, form the most reliable barometer of general economic and commercial conditions. Under normal prewar conditions over two-thirds of the sulphuric acid produced was used in the manufacture of fertilizers. Under war conditions there is an enormously increased demand since the acid is used in large quantities in the production of practically all high explosives. Sulphuric acid is also used in the manufacture of rayon and other cellulose products and in the paper pulp industry. It is estimated that the various peace time requirements for sulphuric acid in Georgia are approximately 250,000 tons of commercial acid per year.

It is possible that the demand for sulphuric acid within the state, together with the increased value of certain associated metals and minerals found in pyrite, such as gold, zinc, and lead, will encourage the reopening of our pyrite deposits with a view to establishing and operating concentrators and sulphuric acid plants, producing sulphuric acid, iron ore from sinter (roasted residue), zinc and lead concentrate, and metallic gold. This possibility is rendered more promising with gold at $35.00 per ounce, as compared with the former value of $20.00 per ounce.

HISTORY. The discovery and exploration of the Georgia pyrite veins started with the period of gold mining about 1830. The early gold miners, however, desired only oxidized ores, and as it was found that the deposits of pure pyrite carry little or no gold, and the gold-bearing veins were largely quartz with relatively small amounts of pyrite, little work was done on the larger pyrite deposits. With the discovery of the Ducktown copper deposits in the late "forties," a period of extensive prospecting commenced, and continued until the outbreak of the Civil War. During this period pits were sunk on almost all showings of pyrite or gossan in the state, and very few pyrite deposits have been discovered since which do not show traces of the work of the old copper prospectors. But in spite of all the prospecting, the only deposits found rich enough in copper to be worked even on a small scale were the No. 20 and Mobile Mines in the Ducktown district and the Canton copper mine, Cherokee County.

During the twenty years following the Civil War some attempts were made to mine copper, but at that time pyrite was not considered as a source of sulphuric acid. In the early "eighties" the Georgia Chemical Company of Atlanta erected the first pyrite-burning acid plant in the South, and to supply this plant the present Tallapoosa and Little Bob mines were opened. The Atlanta plant was operated only a few years, and in 1890 the only pyrite-burning plant in the United States was a small one at Natrona, Pennsylvania. About that time the price of Sicilian sulphur rose from $22.00 to $36.00 a ton, and many acid plants were equipped to burn pyrite, but only lump burners were used and the Spanish ore was imported at such a low price that there was little incentive for developing domestic mines.

The first really successful pyrite mine in Georgia was the Villa Rica Mine of the Sulphur Mining and Railroad Company, which was opened in 1889 and worked almost continuously until 1917. Between 1905 and 1915 the Southern Star, Reeds Mountain and the Swift mines were worked, but the price of pyrite at that time was too low to make the operations profitable.

GEOLOGY. The pyrite deposits of Georgia are found in the crystalline and semicrystalline geological provinces of Georgia, These provinces include the oldest rock formations found within the state. The pyrite deposits occur in three principal rock types characteristic of the crystalline area. These are, in the order of their relative age: first, Carolina gneiss; second, Roan gneiss; third, granite.

CAROLINA GNEISS. Carolina gneiss, the oldest and most extensive crystalline formation, is dominantly light to dark-gray in color and weathers to a gray, yellow or light red sandy soil. Quartz, mica and feldspar are the principal minerals found. In Georgia a large part of the Carolina gneiss is believed to have been derived from sedimentary rocks. Because of the intense folding and general similarity of the rocks over a great area no estimate of the thickness of the formation can be made. This formation contains no fossils, has been subjected to more than one period of intense metamorphism, and is intruded by the igneous rocks of the area.

ROAN GNEISS. The Roan gneiss in Georgia forms many lenticular or sheetlike masses enclosed in the Carolina gneiss. They range in thickness from a few feet to hundreds of yards, but extensive masses like that at Roan Mountain, North Carolina, from which the formation derives its name, are probably not to be found in Georgia. The most common minerals consist chiefly of hornblende or hornblende

and quartz, although feldspar is abundant in the rock at some localities. These beds are dark-green to black in color but may be banded with light colored layers of quartz and feldspar. Weathering and decomposition produce a characteristic dark-red or chocolate-brown clayey soil. An intermediate stage of weathering is represented by porous, punky, brick-red material which has a tendency to break into rectangular blocks. This has been appropriately named "brick-bat" by the gold miners of the Dahlonega district. The age of the Roan gneiss is almost as great as that of the Carolina gneiss, since both have undergone about the same amount of metamorphism. The Roan gneiss belts are economically important because they carry most of the pyrite as well as the deposits of the crystalline area.

GRANITE GNEISS. There are many granite masses in the crystalline area of Georgia, varying in extent from narrow strips and small patches to areas extending across many counties. Generally speaking, the granite gneisses are younger and have intruded into both the Carolina and Roan gneisses. The granites are not known to contain any pyrite deposits, but many important deposits occur within a fraction of a mile of the borders of some of the large granite masses. Therefore, from the standpoint of origin of the pyrite deposits, the relationship may be inferred.

TYPES OF DEPOSITS. The pyrite deposits of Georgia show great variations in character of ore and associated rocks. It is believed that all may be classified under four general types; first, metamorphosed pyrite veins generally associated with roan gneiss; second, limestone replacements; third, pyrrhotite veins; fourth, disseminated deposits in basic rocks. Deposits of the first two types only are known to be of commercial importance.

METAMORPHOSED PYRITE VEINS. Most of the commercially important pyrite deposits outside the Ducktown area are of the metamorphosed vein type. The principal area of distribution is along a belt about ten miles wide and 150 miles long, extending northeast across the state from Carroll to Rabun County; but a few isolated deposits occur outside this belt. The deposits near Bremen, Villa Rica, Hiram, Marietta, Creighton and Dahlonega all belong to this class, and those of Towns and Rabun counties are apparently of the same character.

The age of the deposits cannot be determined very definitely. Both pyrite and gold quartz veins must have been deposited by solutions given off at different stages during the cooling of the intrusive mag-

mas. The granites range in age from Pre-Cambrian (oldest age) to late Paleozoic, and the masses with which most of the pyrite deposits are associated appear to be of comparatively late age.

LIMESTONE REPLACEMENTS. Limestone replacement deposits in Georgia occur only in the metamorphosed Paleozoic rocks (Great Smokey formation), and include those of the Ducktown area and the Tallapoosa mine. Briefly, the ores consist of pyrrhotite, pyrite, chalcopyrite, sphalerite, bornite, specularite, magnetite, actinolite, calcite, tremolite, quartz, pyroxene, garnet, zoisite, chlorite, mica, graphite, titanite, and feldspar.

DISTRIBUTION OF DEPOSITS. The pyrite deposits of Georgia occur principally in one irregular belt across the state, but for the purpose of description the best prospects and developed mines may be grouped partly according to geographic position and partly according to geologic relation in six districts; first, the Carroll County belt; second, the Draketown district; third, the Villa Rica belt; fourth, the Paulding County belt; fifth, the Creighton-Dahlonega belt; sixth, the Ducktown district. There are also a few isolated deposits outside these districts. (See attached map of northern Georgia showing pyrite deposits.)

For a more detailed description of the pyrite deposits of Georgia, reference is made to Bulletin 33, Georgia Geological Survey, Room 425, State Capitol, Atlanta.

CHAPTER IX

ROAD MATERIAL

Road building material in Georgia is quite abundant and fairly well distributed throughout the state. In describing these materials the state will be divided into three divisions: the Paleozoic of northwest Georgia; the Crystalline of central Georgia; and the Coastal Plain of southern Georgia—areas which outline the three main geological divisions of the state.

Since most road materials are not minerals but rocks, the usual procedure will be deferred, and in this section no description of material or geology will be given. Each geological division will be discussed as a separate subject, for in that way the discussion will be more coherent.

PALEOZOIC AREA. Materials used for road construction in the part of the state which comprises all of the following ten counties:

Polk, Floyd, Bartow, Gordon, Murray ,Whitfield, Catoosa, Chattooga, Walker, and Dade, consist of limestones, chert, shales, and sandstones. The limestones of the area are very extensive and are well suited for macadamizing purposes. They may be separated into three divisions: Knox dolomite, Chickamauga limestone and the Bangor limestone. These terms are geologic formation names.

The Knox dolomite is the most extensive of the three formations. It attains a thickness in places of more than 3,000 feet, and occurs in a number of broad and narrow bands crossing the area in a northeast and southwest direction giving rise to broad rounded ridges. The rock consists largely of compact, heavy-bedded, light-gray magnesium limestone always containing considerable silica in the form of chert. The dolomite has uniform texture and crystalline structure. It is easily quarried and is readily crushed, but at the same time has sufficient toughness to form a durable surface. It would be difficult to find a calcareous deposit better adapted to road building.

The Chickamauga limestone, named for Chickamauga, Georgia, overlies and occupies the same area as the Knox dolomite. It occurs in narrow parallel belts, often forming valleys. Its different beds vary greatly, both in mineral structure and mineral composition. Most of the Chickamauga limestone weathers into shale which can be used in road surfacing without being crushed, but its physical character renders it unsatisfactory for prolonged wear. On the other hand, the blue variety of limestone makes any excellent road surface better and it has been extensively used for this purpose.

Bangor limstone is a pure dove-colored limestone about 900 feet thick. It occurs along the flanks of Pigeon and Lookout mountains where it outcrops beneath the sandstones forming their crests. Because of its limited occurrence, it is not widely used for road building, although it would make an excellent surface material.

The chert deposits of the Paleozoic area are quite extensive and widely distributed in the area. They occur in two different geological formations called the Knox Dolomite and Fort Payne Chert.

The chert of the Knox dolomites is coextensive with the limestone and is often considered the more important of the two materials for road building purposes. It occurs as nodules and also in beds several feet in thickness. The chert is formed by the weathering of the dolomite and as such is a residual product. The material is well-suited for lightly traveled roads but is inferior to limestone for use on roads with heavy traffic.

The Fort Payne chert is a siliceous limestone varying in thickness from 50 to 200 feet. Its lower layers consist largely of heavy beds

of chert resembling the chert of the Knox dolomite, but from which it can be distinguished by the presence of numerous fossils. It occurs along the base of Taylor's Ridge and Horn Mountain and at other localities in that vicinity. All of the formations described above were deposited in the sea during ancient times. Their marine origin is indcated by the presence of fossils and marine organisms. They are very old and have undergone a great deal of alteration.

CRYSTALLINE AREA. Road building materials of the Crystalline area consist of granite, gneiss, schists, quartzite, marble, massive quartz, and traprock.

All these materials are a great deal older than the rocks described in the Paleozoic area, and belong either to the igneous group or to the metamorphic group of rocks. The granites are widely distributed throughout the Crystalline area, occurring as large irregular masses in the gneisses and schists. (See preceding section on granite.) Physical tests made on these granites show that they have great strength and are therefore among the best of this class of stone for road building.

Gneiss is more abundant in the Crystalline area than granite and is more suitable for road building. It makes a fair road surfacing material because of its composition, (See preceding section on gneiss.) texture and toughness.

Traprock is very generally distributed over the Crystalline area. It occurs always in the form of dikes which vary in thickness from a few inches to many feet. These dikes, which have originated from the filling up of fissures by molten matter forced up from depths within the earth, have roughly a northwest-southeast trend and are nearly vertical in attitude. The rocks are dark-green or black in color, usually fine-grained and very hard. As a road surfacing material, this type of rock has no equal. Its great hardness and its remarkable toughness, together with its excellent binding quality, make it an ideal road building material.

The other rocks mined in the Crystalline area, such as schist, quartzite, and marble, are somewhat inferior to those described above, although they are used widely for this purpose.

COASTAL PLAIN AREA. The road building materials of the Coastal Plain area are limestone, flint, sand and gravel. Along the Atlantic seacoast, sea shells have a limited use for road building. The limestones of south Georgia outcrop at many points in the Coastal Plain. As has been said, they are soft and somewhat porous, although at some localities they are quite compact and partly crystalline. The softer varieties have been used extensively for road and street surfac-

ing in south Georgia. It seems to give satisfaction because it readily cements into a compact hardened surface comparatively free from dust. The cheapness with which these limestones can be prepared make them the most valuable material of the area for road surfacing. The hard limestones appear to have been little used for this purpose.

Flint is abundant in the vicinity of the Flint River. It is generally hard and associated with limestone, sand, and clays. It is not satisfactory for use alone as a surfacing material, but when mixed with soft limestone will make a very good road.

Sand and gravel deposits are quite plentiful along the Fall Line which extends from Columbus through Macon to Augusta. Often thick beds are found covered by a thin sand overburden which makes quarrying comparatively easy. Many of the rivers also contain sand and gravel deposits which are easily accessible; consequently a large percentage of roads in the Coastal Plain of Georgia are surfaced by gravel which forms an all-weather highway.

Rock Wool

Rock wool is not a natural product but is prepared from such natural substances as limestone and shale. It is white, with the appearance of loose wool or raw cotton. Actually it is a glass which has been spun into fine threads.

Location. Wool rock, that is rocks from which rock wool can be made, occurs in the Paleozoic area of northwest Georgia, probably in the Crystalline Belt of central Georgia, and in the Coastal Plain area of south Georgia.

Geology. Wool rock is usually a limestone which contains the proper amount of silica, magnesia, and other elements necessary for its conversion to wool; however, rock wool is also made today from a great variety of natural materials and artificial products which include clay, waste glass, waste china, furnace slag, and even sand and gravel. Chemical analyses and actual laboratory tests must be made of any substance before it can be definitely classified as suitable for the manufacture of rock wool.

Wide spread deposits of siliceous dolomites and other rocks occur in northwest Georgia. These rocks belong to the Paleozoic era at which time they were laid down in the ocean. Since then they have been lifted up, folded and eroded, so that their upturned edges crop out in thousands of localities. Rock wool can be made from these rocks.

Manufacture and Uses. Rock wool, although a new industry, is manufactured at many places throughout the United States. No rock wool is at present manufactured in Georgia but it is an industry much needed in the state.

Many of the principles used in the manufacture of rock wool are secret. Generally the fragments of rock are heated in a cupola furnace, similar to that in a foundry for melting iron, until they are molten. This molten rock is then permitted to flow in a stream from the furnace and as it does it is subjected to a blast of air or steam that blows it into rock wool.

Uses for rock wool are increasing every day. It is extsnsively used in the construction of modern houses. Blown between the walls it acts as an insulator, being particularly useful in air-conditioned buildings. It is used to wrap steam pipes; in refrigerators and ice boxes; in soundproofing buildings; in packing acids and other corrosive substances for shipment, and in many other ways.

Sand and Gravel

Sand and gravel are both widely distributed throughout the state. They are especially abundant in the northwest part of the Coastal Plain near the Fall Line. Excellent deposits of sand occur near Noward in Taylor County; Junction City in Talbot County; on Bull Creek, 3 miles east of Columbus in Muscogee County; on the west side of Flint River at Bainbridge, Decatur County; on Flint River near Albany; on the east bank of Little Ogeehcee River near Lumber City in Telfair County, and on the east bank of Oconee River at Dublin, Laurens County. In addition to these localities are numerous others where deposits of sand and gravel may be found.

In the Crystalline and Paleozoic areas sands and gravel are mostly found along streams but there are some stratified beds having considerable area. In the latter case, the sand is in the form of friable sandstone which is easily crushed.

Geology. The sand and gravels of the Coastal Plain vary in age from Cretaceous to Pleistocene. Those of the Piedmont, with the exception of the recent stream deposits, are probably Pre-Cambrian; those of the Paleozoic area vary from Cambrian to Pennsylvanian.

The sands of the Coastal Plain are both marine and continental deposits. Their thickness is extremely variable and in most cases they are lenslike in character. The sand and gravels of the Tuscaloosa formation, which is the base of the Cretaceous, has been derived from the crystalline rocks of the adjacent Piedmont.

The size of gravel in this formation varies from sand to boulders. It is composed chiefly of quartz. In the Piedmont and Paleozoic areas, sand and gravel may occur as regular beds but those formed in stream channels exist as bars and shoals formed by the action of running water.

USES. Sand is extensively used for various kinds of structural work, for molding purposes, for glass and furnace sand, and for a great many other uses. Gravel is largely used for roofing, road surfacing, and similar purposes.

SERICITE

Sericite of excellent quality is found in Pickens County in the vicinity of Jasper where it is now mined. It occurs interbedded with other rocks of sedimentary origin. The beds vary in thickness from a few inches to 15 or 20 feet.

When pure, sericite very closely resembles talc. It is however an altered sedimentary deposit; whereas talc deposits are derived from the alteration of igneous rocks. It is white to apple-green in color and very finely micaceous. Good sericite occurring in beds several feet thick has valuable economic possibilities. It is used in preparation of roofing and also competes with talc in the preparation of paints.

SLATE

Slate, once the most popular roofing material for the better class of buildings, has in recent years been largely supplanted by artificial forms of roofing material such as asphalt and asbestos shingles.

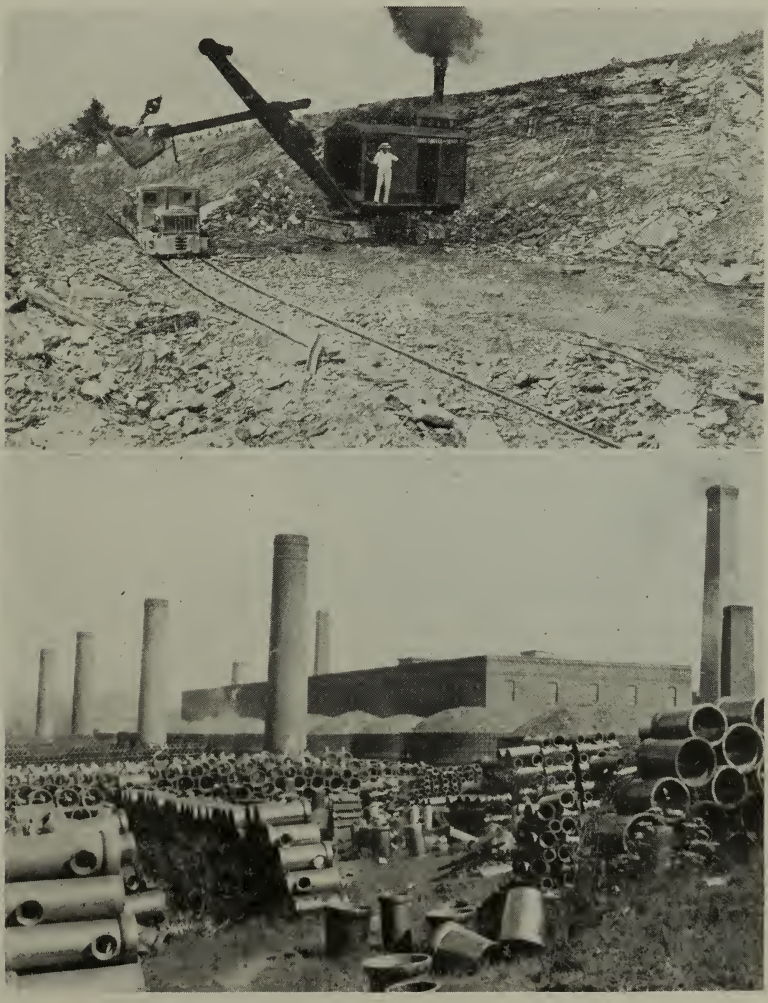
LOCATION. Slate suitable for roofing purposes is found in Polk, Bartow, Gordon, and Murray counties. The Rockmart belt extends from a point about three miles south of Cartersville in Bartow County southwest to about five miles south of Rockmart in Polk County. A smaller belt occurs southwest of Cedartown in Polk County. The Fairmount belt extends from near White in Bartow County northward through Fairmount, in Gordon County, into the southern part of Murray County.

GEOLOGY. The Georgia slates are metamorphosed sedimentary rocks of Paleozoic age. They were probably laid down under the ancient Paleozoic ocean as beds of clay and were later consolidated into shale. At the time of the formation of the Appalachian Mountains (See section on granite.) the beds wer estrongly folded and were metamorphosed by heat and pressure, forming new minerals. It is

probably the parallel orientation of these minerals at right angles to the direction of pressure that gives the slate its cleavage and makes it valuable as a roofing material.

The slates of the Rockmart and Cedartown belts are of a dark-blue to black color. Those of the Fairmount belt are of a pleasing greenish color.

HISTORY. The first slate quarries in Georgia were opened in the Rockmart district of Polk County about 1850 and were operated



SHALE—*Above—Shale pit in Gordon County. Below—Shale converted into sewer pipe at a plant in Walker County.*

until the Civil War. About 1880 the quarries were reopened, and from that year until 1900 was the period of greatest development. The largest reported production was in 1894, with 5,000 squares valued at $22,500. In the past twenty years the only production has been that of one man who solicits orders for slate roofs, quarries and splits the slates himself, and applies them to the roofs. The total production of the district is probably in the neighborhood of 50,000 squares.

The green slates of the Fairmount district were discovered about 1908 during the construction of the main line of the Louisville and Nashville Railroad. Only a small production of roofing slate has been reported from the district, but since 1920 one company has been grinding slate into slate granules used in the manufacture of composition roofing.

TALC AND SOAPSTONE

DESCRIPTION. Talc is a soft, white or apple-green colored mineral that grinds to a white, slick product. It is generally found in leaf-shaped or "mica-shaped" particles. Sometimes these particles make up the entire mass; at other times they are associated with other minerals, or are scattered through the rock. Impure talc is called soapstone. Soapstone was first used by the Indians who carved it into pipes and bowls.

LOCATION. Talc and soapstone may be found throughout the Crystalline Belt of Georgia and have been recorded in many localities, particularly in Habersham, Rabun, White, Cherokee and Paulding counties. It has been mined 3½ miles south of Blue Ridge, on the Louisville and Nashville Railroad, about two miles west of Ball Ground, and in other places. At the present time, talc is mined extensively on the steep slopes of Fort Mountain in Murray County.

The foliated talc specimens which are sent out with the high school museum exhibits came from the Verde Antique Marble Company quarry near Holly Springs, Cherokee County.

GEOLOGY. Most of the talc and soapstone deposits are produced through changes in megnesium-bearing igneous rocks; thus talc and soapstone go back in their early history to molten rock. The molten rock hardened or crystallized into various minerals. Later these minerals were changed to talc.

MINING AND USES. Talc and soapstone, mined at present in Murray County, near Chatsworth, are removed from tunnels dug into the steep sides of Fort Mountain. Miners dig and blast the talc

and soapstone free from the rock, throw it into mine cars and push it out of the winding tunnels. From the mountain, it is hauled by trucks to the talc mills at Chatsworth. Here it is graded and ground into fine dust. The coarser powder is ground to about 40-mesh; that is, if we divide a square inch into 40 squares, this powder will go through the holes in such a sieve. This coarse grade talc is used in the preparation of roofing. Much talc is ground to 200-mesh. This finely-ground talc is mixed with rubber, particularly for making automobile tires. The best grades of talc at Chatsworth are cut into pencils which are used for marking steel. Most of the talc pencils used in the world are made at Chatsworth.

Pure high-grade talc is ground very fine and used in paint to which it adds weight and whiteness and, because of talc's slick, greasy character, facilitates easy spreading of paint on a surface.

TRIPOLI

LOCATION. All of the tripoli deposits of Georgia occur in the Paleozoic area of northwest Georgia. Deposits are found in Catoosa, Whitfield, Walker, Murray, Chattooga, Floyd, Polk, Bartow, and Gilmer counties where they are associated with outcrops of Knox dolomite. This bed has been extensively worked in the vicinity of Dalton, and also near Lyerly in Chattooga County.

GEOLOGY. Tripoli, otherwise known as "rotten stone," is a residual product derived from the Knox dolomites. The material is confined to certain beds of this formation where is occurs in the form of irregular deposits associated with impure clay and chert. The beds vary from a few inches to several feet in thickness.

HISTORY. The name "tripoli" comes from northern Africa where a deposit of silicaous earth has long been known to occur near Tripoli in Italian Lybia. At that locality the earth is made up of minute marine shells and animals called diatoms. Thus the rock is sometimes called diatomaceous earth. There are no known deposits of diatomaceous earth in Georgia but the material found in northwest Georgia is so closely comparable to it that no distinction is made by the geologist.

The Georgia tripoli deposits were discovered about 85 years ago near Dalton and were used locally as an abrasive. These deposits have been only partially developed. Shipments have been recorded from Chattooga, Murray, Walker, and Whitfield. No mining is now being carried on. Although there is a recurrent impression among

users that Georgia tripoli is distinctly inferior to that of other states, it has been shown by the Division of Mines, Mining and Geology that this is erroneous. Georgia producers have worked under a handicap of shipping unmilled material which means that no guarantee of a uniform product can be given. The deposits are believed to be of sufficient purity to invite further development, but satisfactory marketing will not be achieved without screening and grading.

DESCRIPTION OF MINERAL. Georgia tripoli is a siliceous earth containing small percentages of iron oxide and aluminum oxide. Generally the silica content is greater than 90 per cent. It ranges in color from white and ivory to a reddish-brown, the last being due to the iron content. It is extremely light in weight and very porous, as well as extremely fine-grained. It has no definite chemical composition because of its residual origin, which is thought to be the explanation for most deposits.

MINING. Tripoli is mined both by underground and opencut methods. Many of the Georgia deposits are covered by a few feet of overburden and can be mined by surface methods. Underground operations were employed in Walker and Whitfield counties but the mines are now abandoned.

The crude tripoli is hand picked and generally classified in two grades, white to cream, and pink. It is then dried and shipped without further separation. In other states, milling methods involve crushing, pulverizing, and screen and air separation for particular uses. This is not done in Georgia at present, but is recommended.

USES. Tripoli is mainly used as an abrasive. It is particularly suited as a buffing and burnishing agent and in many instances is so employed in scouring soaps and powders. The next most important use is a filler. It is widely used in special paints, in the manufacture of rubber, and in refractory cements. It is also used in other kinds of cements and concrete.

Coherent and compact blocks are cut to desired shapes and sizes and used in water filters. With intelligent development, Georgia tripoli can undoubtedly be made into a profitable business.

VERMICULITE

Vermiculite is a variety of mica. Crude vermiculite is a mass of dark brown, bronze or golden-colored micaceous flakes or small sheets. The flakes are flexible but not elastic.

Vermiculite deposits of Georgia have not yet been developed. They are known to occur in Rabun and Towns counties, but they may occur practically anywhere in the Crystalline Belt in the state.

When vermiculite is heated it expands to a very light, fluffy, bronze-colored material weighing only five to ten pounds per cubic foot. After it has been treated with heat it may be used for various purposes. It is an excellent heat insulator, and for this purpose is manufactured into boards and used in refrigerators, ovens, fireless cookers, incubators, etc. Sometimes, it is used between the walls of houses as a fireproof wall board. Many other uses exist.

CHAPTER X

WATER AND WATER POWER

Georgia's most important mineral resource, although we seldom think of it as a mineral, is water. Without adequate water supplies, both surface and underground, cheap hydroelectric power, industries, inland navigation, and even life itself would not be possible. The making of water available for municipal and industrial consumption and the production of hydroelectric power are major utilities in Georgia.

Municipal and Industrial Water Supplies. Approximately one hundred million gallons of water must be secured, purified, stored and delivered every day to supply the demands of the 340 communities in Georgia having public water supplies. This essential material is delivered in the consumers' homes at any time of the day or night at a cost of less than ten cents per ton. Every gallon of water delivered must be safe to drink and also satisfactory for manufacturing purposes. To accomplish this requires unceasing vigilance to protect the safety and uninterrupted service of the supply.

In the early days every house had its own water supply from either shallow dug wells or springs, but as the density of population increased it was not only impossible to get sufficient water by this method but also to get unpolluted water. About 60 to 75 years ago the drilling of artesian wells was begun. An artesian well is one in which the level of the water rises in the well above the point at which the water is struck. If it rises to or above the surface it is a flowing well. Artesian wells proved to be an adequate source of municipal water supplies in most parts of the Coastal Plain area of south Georgia, but not in the rest of the state.

The northern half of the state is largely underlain by dense crystalline rocks having practically the same physical characteristics as granite. These rocks are not in themselves water-bearing, but contain water only in the fissures and joints that intersect them. If a deep well happens to strike enough of these fissures and joints it may yield enough water to supply a small town. Such wells, however, often decline rapidly in yield, forcing the town to drill other wells or seek a supply of surface water. Many wells that have been drilled in this area have yielded an insufficient supply or have actually been dry holes. Costly experience has taught us that municipalities in the Piedmont and mountain sections of Georgia cannot depend on an underground supply of water but must take their supply from a surface stream. Some cities, such as Griffin, have learned this and have already turned to a surface supply with modern plants for filtering and purifying the water. Other cities will in the next few years be forced to abandon their dwindling underground water supply and turn to surface streams.

Many areas in the southern half of the state are underlain by sedimentary beds that yield large quantities of water, although the water is often hard because of dissolved mineral matter and must be softened before it can be used as a municipal supply. Even in these areas the supply of underground water is by no means as inexhaustible as popular opinion would have it. Continued draft in certain localities has shown that underground water supplies can be depleted and that surface streams in south Georgia will eventually replace many existing deep wells for municipal and industrial supplies.

The water supply of a city or town must keep ahead of population increases and industrial expansion. This requires long-range financial and engineering planning on the part of each municipality. It also requires careful planning for the entire state because no city or town lives within itself in the matter of water supply. The same surface streams and underground waters are used by many towns. Thus every water supply is directly related to and influenced by others. Very little thought or action has been taken by the state as a whole in planning and properly utilizing its water resources for the future. The importance of studying our underground water resources and measuring the flow and quality of surface streams will be discussed later.

WATER POWER. The energy of falling water has long been used in Georgia to run many small gristmills and in the "1840's" it began to be used as a source of power for factories and mills. The Augusta

Canal was built in 1847 as a source of power for several industries along the banks of the Savannah River. The generation of electricity by water power and its transmission to cities and industrial centers for power and light began in Georgia in the first decade of the present century and has progressed rapidly, although only a small part of the potential water power of Georgia is being utilized. In the following table of the developed water-power sites in Georgia it will be noted that the water of the Tallulah River is used over and over at

WATER POWER—*Numerous hydroelectric plants are located along streams of Georgia. View of water power dam and lake at the famous Tallulah Falls in Habersham County.*

four plants on the Tallulah River and at two plants just below its mouth, on the Tugalo River.

The undeveloped water-power sites in Georgia are mostly in the Piedmont and mountain sections of the state where the streams have their sources and have a relatively high gradient. The streams flowing from these areas into the Coastal Plain rapidly lose their rate of fall and there are comparatively few power sites in South Georgia. The total undeveloped water power of Georgia cannot be estimated without more adequate topographic maps and many stream flow measurements carried on over a period of several years.

NEED FOR WATER INVESTIGATIONS. In spite of the fact that water is our most important natural resource, we have collected very little information about it in Georgia. We know the location of our

WATER POWER PLANTS OF 100 HORSEPOWER OR MORE IN GEORGIA
DECEMBER 31, 1937

NAME OF STREAM	PLANT NAME	NAME OF OPERATOR	TYPE OF PLANT	TOTAL CAPACITY IN HORSEPOWER
Augusta Canal (Savannah River)	Augusta Canal	Georgia Power Co	P. U.	2,400
Savannah River	Stevens Creek	South Carolina Power Co.	P. U.	25,000
Tugalo River	Yonah	Georgia Power Co.	P. U.	42,600
Tugalo River	Tugalo	do.	P. U.	88,000
Tallulah River	Burton	do.	P. U.	12,000 (a)
Tallulah River	Nacoochee	do.	P. U.	8,400
Tallulah River	Terrora	do.	P. U.	30,400
Tallulah River	Tallulah Falls	do.	P. U.	111,600
Toccoa Creek	- -	E. P. Simpson and Co.	P. U.	250
Beaverdam Creek	Municipal	City of Elberton	P. U.	357
N. Fork Oconee R.	Hurricane Shoals	Georgia Power Co.	P. U.	200 (b)
Little Ogeechee R.	Hamburg	Gilmore Brothers	Ind.	100
Oconee River	- -	Athens Manufacturing Co.	Ind.	650
Oconee River	Barnett Shoals	Georgia Power Co.	P. U.	5,010
Middle Oconee River	Tallassee	do.	P. U.	2,380
Middle Oconee River	Mitchell	do.	P. U.	700 (c)
Ocmulgee River	Juliette	Juliette Milling Co.	Ind.	1,690
Ocmulgee River	Lloyd Shoals	Georgia Power Co.	P. U.	33,000
Yellow River	Millstead	Callaway Mills	Ind.	1,000
Yellow River	Porterdale Dam	Bibb Manufacturing Co.	Ind.	3,306
Towaliga River	High Falls	Georgia Power Co.	P. U.	5,000
Flint River	- -	Crisp County	P. U.	9,600
Flint River	Flint River	Georgia Power Co.	P. U.	8,250
Whitewater Creek	Whitewater	do.	P. U.	540

Spring Creek	- -	Georgia Power and Light Co.	P. U.	1,220
Chattahoochee River	Langdale	Georgia Power Co.	P. U.	5,762
Chattahoochee River	Riverview	do.	P. U.	650
Chattahoochee River	Goat Rock	do.	P. U.	25,600
Chattahoochee River	N. Highland No. 1	do.	P. U.	10,010
Chattahoochee River	N. Highland No. 2	Bibb Manufacturing Co.	Ind.	1,477 (d)
Chattahoochee River	City Mills	Georgia Power Co.	P. U.	450 (c)
Chattahoochee River	Eagle and Phoenix	Eagle and Phoenix Mills	Ind.	6,150
Chattahoochee River	- -	City Mills Co.	Ind.	1,024
Chattahoochee River	Morgan Falls	Georgia Power Co.	P. U.	23,100
Chattahoochee River	Dunlop	do.	P. U.	3,000 (e)
Soque River	Porter and Hodges Shoal	Habersham Mills	Ind.	1,925
Chestatee River	- -	Chestatee Pyrites Co.	Ind.	800 (c)
Vickery Creek	- -	Roswell Mills	Ind.	650
Pataula Creek	Credille	Georgia Power Co.	P. U.	2,500
Etowah River	Etowah Mills	Thompson-Weinman and Co.	Ind.	800
Chattooga River	Trion Factory	The Trion Co.	Ind.	750
Toccoa River	Blue Ridge	Tennessee Electric Power Co.	P. U.	30,000
Chattahoochee River	Bartlett's Ferry	Georgia Power Co.	P. U.	78,000 (e)
		TOTAL HORSEPOWER		586,301
		Total number of plants		43

Note: "P. U." indicates utility. "Ind." indicates power used principally for manufacturing purposes by plant owner; in many cases power is also used for lighting mill villages.

(a) — At 100-foot head; maximum capacity 15,000 H.P.

(b) — Out of service during 1936 and 1937 but not yet definitely abandoned.

(c) — Not operating at present.

(d) — Leased from Georgia Power Co.

(e) — Capacity at 112-foot head; maximum capacity not given.

streams, but we have few measurements of the quantity of water that they carry in flood time, or in dry time, or of the chemical purity of that water. This information can be obtained only by stream gaging (measuring the flow of these streams every hour of the day over a period of many years so as to get their records in periods of extra high floods or unusual droughts) and by taking samples of the water at regular intervals and making chemical analyses of them.

Until 1937 Georgia was the only state in the South not collecting such information, but the legislature of that year made a small appropriation for this work, which was matched by an equal amount of money from the Federal government. The work is done by the trained hydraulic engineers of the U. S. Geological Survey in charge of a District Engineer for Georgia with headquarters in Atlanta. At the end of the first year's operation 49 stream gaging stations were in operation on the larger streams throughout the state. Additional stations are needed on some of the larger streams and on many of the smaller ones. Daily samples of water are being collected and analyzed at five of these gaging stations, and intermittent samples at the other stations. The investigation of the quality of water also includes chemical analyses of the municipal water supplies and a start has been made to determine how far up the coastal streams the influence of salt water is felt.

Intensive studies of our underground waters are equally needed. We know very little as to what underground beds are water-bearing, the depth to them at various localities, and the amount of water that can be safely taken from them. We do know that at certain localities such as Savannah, Brunswick and Albany, the deep wells were once flowing wells, but as additional wells were drilled the water level dropped until now it is some distance below the surface and is slowly being lowered. This means that the water is being taken from these beds at a faster rate than it is being supplied by rainfall at the point where these beds crop out at the surface of the ground. Unless water can be obtained from deeper beds, and all waste of the underground water by wild flowing wells stopped, these cities will one day be faced with acute water shortage. A study of our underground water resources and the best methods of utilizing them is essential.

GEOLOGIC TIME TABLE

ERA	SYSTEM	SERIES	DOMINANT LIFE
Cenozoic	Quaternary	Recent Pleistocene	Cave man in Europe during the Glacial Epoch. The beginning of modern times. MAN
	Tertiary	Pliocene Miocene Oligocene Eocene	Development of modern mammals and rise of man. MAMMALS
Mesozoic	Cretaceous		The rise of modern land plants. Dominance of reptiles: flying reptiles, sea-living reptiles, dinosaurs.
	Jurassic*		The first birds. REPTILES
	Triassic*		The first mammals.
Paleozoic	Permian*		Earliest true reptiles; spiders, cockroaches, crayfish, beetles. Extinction of many marine forms of life.
	CARBONIFEROUS: Pennsylvanian		
	CARBONIFEROUS: Mississippian		AMPHIBIANS
	Devonian		First amphibian record. Shell fish. Age of fishes.
	Silurian		Corals, bryozoa, crinoids. INVERTEBRATES brachiopods, trilobites
	Ordovician		Rise of fishes.
	Cambrian		Brachiopods, trilobites. First abundant marine animal life.
PRE-CAMBRIAN: Proterozoic			Primitive multicellular forms.
PRE-CAMBRIAN: Archeozoic			Unicellular forms.

*Not known in Georgia.

GLOSSARY

ABRASIVE—A substance used for grinding and polishing.

ACCESSORY MINERALS—The least abundant minerals of a rock.

"ACTIVABLE" CLAY—A clay which, when treated with acid, acquires the property of bleaching animal, vegetable, and mineral oils.

ADAMANTINE—Diamondlike in hardness and luster.

AGGREGATE—A miscellaneous assortment of rocks, either loose or cemented together.

ALKALI—A substance with marked basic properties; opposite of acid.

ALLUVIUM—Mud, sand deposited by streams.

AMALGAM—An alloy or union of mercury with another metal.

AMALGAMATION—The process of extracting gold and silver from pulverized ore by the use of mercury to produce an amalgam. The mercury is afterward expelled by heat.

ANTICLINE—An arch or upwarp in rock strata; opposite of syncline.

AQUIFER—A rock stratum containing large amounts of recoverable water.

ARRASTRES—An apparatus for grinding and mixing ores by means of a heavy circular stone dragged around on a circular bed.

ASSAY—A method for determining the amount of gold and silver (or other substances) in a rock.

AURIFEROUS—Gold-bearing.

BASIC ROCKS—Igneous rock low in silica and high in metallic bases.

BLISTER COPPER—High grade crude copper from which nearly all the oxidizable impurities have been removed by smelting.

B. T. U.—British Thermal Unit; the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.

BY-PRODUCT—Secondary or additional useful product.

CALCINING—The reduction of a substance to a sinter by means of heat.

CARBONACEOUS—Containing carbon or coal.

CARBONATE—The chemical combination of oxygen and carbon with a metal.

CERAMICS—The study of clay, its preparation and uses.

CHLORIDES—The result of a chemical combination of a metal and chlorine.

CHLORINATION—A process of refining gold; also used in treatment of public water supplies.

CHATOYANCY—Changeable color, or iridescence.

CONCHOIDAL—Shell-like; applied to curved fracture surfaces.

CONGLOMERATE—Miscellaneous collection of rounded and waterworn pebbles and boulders cemented together to form a coherent rock.

CONTACT—The boundary between two geologic formations of minerals.

CONTORTED—Term applied to greatly folded and twisted rock strata.

COUNTRY ROCK—The rock surrounding an ore deposit or vein.

CRUSHING ZONES—Bands of rock granulated or sheared by faulting or earth movement.

CRYPTOCRYSTALLINE—Very finely crystalline or microcrystalline.

DETRITUS—A general term for the debris from solid rock; produced by surface changes.

DIKE—Rock formed by igneous intrusion; long and thin in shape; wall-like; usually vertical or nearly so.

DIMENSION STONE—In quarrying, a term used to designate blocks of stone cut to desired sizes.

DIP—The angle at which beds or strata are inclined from the horizontal.

DISSEMINATED—Scattered or diffused.

DRAGLINE EXCAVATOR—A movable power machine with steel bucket hung by cables from end of long boom. Not to be confused with a dragline which is stationary and which has no boom.

DREDGE—Power operated scoop or suction aparatus for removing mud and sand from deposits. In gold mining it is equipped with screens and gold-saving devices.

EROSION—The eating away or wearing down of the surface of the land by the action of water and wind.

FAULT—A break in rock strata or beds accompanied by displacement or movement (usually more or less vertical) of adjacent points along the break.

FAULTING—The movement which displaces adjacent rock masses.

FINENESS OF GOLD—The proportion of pure gold in jewelery, bullion, or coin, expressed in parts per thousand.

FLUMES—An inclined channel, usually wood, for conveying water to be used in gold mining.

Students observing methods of treating gold ores at Dahlonega.

FLUORESCENCE—The emission of visible light from within a substance upon being exposed to direct radiation of invisible ultraviolet rays.

FLUX—Chemical compounds or minerals added to a fusion mixture in order to lower the melting points of other minerals or metals.

FOLIATED—Leaflike; the property of splitting into thin leaves.

FRACTURE—The way a rock or mineral breaks.

FREE GOLD—Gold found uncombined with other substances.

FREE MILLING—Ores that contain gold or silver which can be reduced by crushing or amalgamation without roasting or other chemical treatment.

FULLING—Cleansing or removal of grease from wool.

GNEISS—A layered crystalline rock with cleavage but without the easy separation of schist.

GRIZZLY—A grating of iron or steel bars for screening ores.

HACKLY—An adjective denoting the irregular or uneven fracture surface of minerals or rocks.

HEXAGONAL—Six-sided.

HORIZON—A stratum, bed or formation of any age.

HYDRATE—A mineral substance containing an appreciable amount of water in chemical combination.

HYDRAULIC GIANT—An apparatus using water power under tremendous pressure for washing away rock in some kinds of mining.

HYDRAULICKING—The act of washing down a gravel bank by means of a high pressure water jet.

IGNEOUS—Rocks solidified from the molten state; *i. e.*: lava; granite.

IMPERVIOUS—Impassable; usually applied to clays and shales which prevent the passage of water, gas, or oil.

INTERBEDDED—Alternately layered.

INTRUSIONS—Igneous rocks, which when molten, forced their way into or between other rocks, solidifying before reaching the surface of the ground.

INTRUSIVE—Once molten igneous rocks which forced their way into other rocks and then solidified before reaching the surface; opposite of extrusive.

LEACHING—The chemical removal of soluble substances, leaving insoluble rock residues.

LENS—A body of ore or rock, thick in the center and thin on the edges; similar to a double convex lens.

LENTICULAR—An adjective meaning shaped like a lens.

MAGMA—Liquid molten rock.

MATRIX—The rock or earthy material containing a mineral or metallic ore; sometimes called groundmass.

METAMORPHIC—Adjective of metamorphism; produced by or pertaining to metamorphism.

METAMORPHISM—Any change or alteration in the texture or composition of a rock after its formation, produced by external agencies; associated with heat and pressure below the earth's surface. The processes and results of weathering are generally not included.

METAMORPHOSED—Altered by metamorphism.

NODULE—A small roundish or spherical lump of mineral earth.

NODULIZE—To convert into nodules.

ORE—Any mineral or rock sufficiently rich to be commercially valuable.

ORE BODIES—A solid, more or less continuous mass of ore whose form and character are different from the surrounding country rock.

OUTCROP—An exposure of rock or ore on the surface of the ground. Also used as verb.

OVERBURDEN———Any material lying on top of an ore deposit.

OXIDE—Chemical combination between oxygen and a metal.

PERCOLATION—Slow filtration as of oil through a bleaching clay.

PERMEABLE—Permitting the passage of liquids.

PINCHES AND SWELLS—The thinning and thickening of a vein, ore body, or bedded deposit.

PLACER—A stream deposit where gold may be obtained by washing.

PLASTICITY—The property of being molded, as in clay.

PLATY—Platelike; irregular disc shape.

POROSITY—Open spaces or voids within a rock; not the same as permeability.

PRECIPITATION—The formation or settling out of solid matter from liquid solutions.

PUNKY—A spongy earthy mass.

REFRACTORY MATERIAL—A substance which resists the action of heat or chemicals, undesirable in ores but necessary in furnace linings, flues, spark plugs.

REPLACEMENTS—The process by which some mineral or chemical substance takes the place of an earlier mineral, often preserving the original mineral's shape and crystalline structure.

RESIDUAL—Rock material left in place after weathering has taken place.

RUBBLE—Roughly broken fragmentary, or decomposed rock.

RIFFLES—Corrugations across the bottom of a trough or gold sluice box.

RIFT—A crack or broken place in rock.

RIPRAP—Large irregular pieces of stone to protect jetties, sea walls or embankments.

SAPROLITE—Decayed rock remaining in place over gold-bearing quartz veins; contains some gold.

SCHIST—A foliated crystalline rock formed by metamorphism; easily split; contains more or less mica.

SEDIMENTARY—An accumulation of transported rock fragments deposited or precipitated either in or out of water.

SEDIMENT—A deposit of transported rock fragments.

SHEARING ZONE—A zone of crushed and mashed rock; generally associated with faults.

SHEETING PLANES—Small, closely spaced parallel fractures in rock usually nearly horizontal or parallel to the surface.

SILICATE—The result of a chemical combination between silicon, oxygen, and a metal.

SINTER—Kind of cinder produced by heating but not quite melting; deposits from some types of springs.

SMELTER—A furnace in which metallic ores are freed from impurities and in which the metal is concentrated.

SPECIFIC GRAVITY—The ratio between the weight of a body and the weight of an equal volume of water.

STAMP MILL—One of the earliest methods of pulverizing gold ores.

STRATA—Layers or beds or rock; plural of "stratum."

STRIKE—A direction; usually measured as degrees from north.

STRINGER—Narrow veins or extensions from larger veins into the country rock.

SOLUTION—Usually a liquid containing dissolved mineral water.

SULPHIDE ORE—Metallic ore containing a high percentage of sulphur in combination.

SULPHIDES—The result of chemical combinations between sulphur and a metal.

SYNCLINE—A downward flexure of rocks in the earth's crust; opposite of anticline.

TERMINATIONS—The ends; applied to the end faces of crystals.

UNCTUOUS—Having an oily, slippery, or greasy feel.

VEIN GOLD—Gold found in quartz veins.

WEATHERING—The chemical and mechanical actions of water and air upon rocks causing their disintegration.

WEATHERED—An adjective describing the effects upon rocks caused by weathering.