MISSISSIPPI
State Geological Survey

E. N. LOWE, Director

BULLETIN No. 19

The Bauxite Deposits of Mississippi

— BY —

Paul Franklin Morse

DECEMBER, 1923

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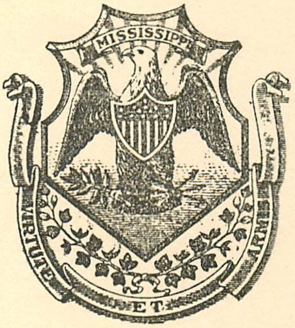

The Bauxite Deposits of Mississippi

— BY —

Paul Franklin Morse

Chemical Analyses

— BY —

William Flowers Hand, Ph. D.
State Chemist

DECEMBER, 1923

STATE GEOLOGICAL COMMISSION

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LETTER OF TRANSMITTAL

Office of the State Geological Survey,
Old Capitol, Jackson, Mississippi,
November 15, 1923

To His Excellency, Governor Lee M. Russell, Chairman, and
Members of the Geological Commission:

Gentlemen:

During the winter of 1921-1922 bauxite in commercial quantity and quality was discovered in Mississippi by J. W. Adams, an enterprising and intelligent prospector from Arkansas.

While this material was noted in this State many years ago by Doctor Hilgard, the quantity was small, and the significance of the find was not then known. Only within recent years has bauxite become commercially important, chiefly as a source of metallic aluminum.

Shortly after the discovery by Mr. Adams, a Sheffield, Alabama, developing company, the Mississippi Bauxite Company, entered the bauxite territory, which consisted of a few counties in northern Mississippi, and leased large acreage for development. Mr. Paul F. Morse, who had been Assistant State Geologist during 1921, was employed to survey and carefully prospect this territory. This he did in a very thorough way; the detail and accuracy of his results were possible only by the expenditure, on the part of the Company, of several thousand dollars.

Through the courtesy of the Mississippi Bauxite Company the privilege was extended to Mr. Morse of preparing for the State Geological Survey the accompanying report of the results of their prospecting. The State thus is enabled to issue it at the comparatively small cost of the preparation and printing of the report, as Bulletin 19 of the State Geological Survey.

Respectfully submitted,

E. N. LOWE, Director.

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The bauxite deposits of Mississippi—Continued

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MAP INDEX

All maps have been reduced about one-third from the original drawings.

By inadvertance numbers of maps were erroneously placed, and the error escaped notice until too late to make the alterations without reprinting. The reader will note the following changes:

Correct numbering—

Map No. I, in the text appears opposite page 92 as No. 4.

Map No. II, in the text appears opposite page 148 as No. 10.

Map No. III, in the text appears opposite page 110 as No. 1.

Map No. IV, in the text appears opposite page 116 as No. 3.

Map No. V, in the text appears on page 161 as No. 6.

Map No. VI, in the text appears on page 168 as No. 13.

Map No. VII, in the text appears on page 128 as No. 7.

Map No. VIII, in the text appears on page 140 as No. 11.

Map No. IX, in the text appears on page 146 as No. 12.

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Map No. XI, in the text appears on page 135 as No. 9.

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Map No. XIII, in the text appears on page 163 as No. 14.

Map No. XIV, in the text appears opposite page 164 as No. 2.

The Bauxite Deposits of Mississippi

By PAUL FRANKLIN MORSE

INTRODUCTION

Chemical Composition

There are three hydrated oxides of aluminum: namely, the monohydrate, $Al_2O_3.H_2O$, or $AlO(OH)$, known as the mineral diaspore, containing

Alumina	85.01 per cent,
Water	14.99 per cent;

the dihydrate, $Al_2O_3.2H_2O$, or $Al_2O(OH)_4$, containing

Alumina	73.93 per cent,
Water	26.07 per cent;

and the trihydrate, $Al_2O_3.3H_2O$, or $Al(OH)_3$, known as gibbsite or hydrargillite, containing

Alumina	65.41 per cent,
Water	34.59 per cent.

The chemical formula of bauxite according to Dana is essentially $Al_2O_3.2H_2O$; and this is the one that has been generally accepted. Diaspore and gibbsite are definite minerals, found in crystalline form; but the dihydrate has never been identified in the pure state and its existence as such is doubtful. It seems probable that bauxite is not a distinct mineral; but rather a rock composed of at least two and possibly all three hydrates of alumina, ranging from diaspore ($Al_2O_3.H_2O$) through theoretical bauxite ($Al_2O_3.2H_2O$) to gibbsite ($Al_2O_3.3H_2O$); and varying amounts of iron oxide, water and silica, and more or less titanium dioxide and clay. The chemical analyses indicate that not all the bauxite deposits of the world belong to the same class. The pure dihydrate contains more than 39 per cent of aluminum, but the grade of ore is generally indicated by giving the percentage of alumina (aluminum oxide), which ranges from less than 40 to more than 70 per cent. In the bauxite deposits of Arkansas, according to W. J. Mead, there is a complete gradation from the composition of gibbsite ($Al_2O_3.3H_2O$) to the composition of kaolin ($Al_2O_3.2SiO_2.2H_2O$).

The following table shows the percentage of aluminum in the various minerals that contain aluminum oxide:

Minerals	*Percentage of aluminum*	*Composition*
Diaspore	45.0	$Al_2O_3.H_2O$
Gibbsite	34.6	$Al_2O_3.3H_2O$
Bauxite as $Al_2O_3.2H_2O$	39.1	$Al_2O_3.2H_2O$
Alunite	19.6	$K_2O.3Al_2O_3.4SO_3.6H_2O$
Kaolin	20.9	$Al_2O_3.2SiO_2.2H_2O$
Sericite	20.4	$K_2O.3Al_2O_3.6SiO_2.2H_2O$
Corundum	52.9	Al_2O_3
Feldspar	---	Variable
Nepheline	17.6	$NaAlSiO_4$
Cryolite	12.8	Na_3AlF_6

Even in its purest form, bauxite contains more or less foreign material, either chemically combined or mechanically admixed. Ferric oxide is usually present in variable amounts, ranging from a trace to a percentage equal to or exceeding that of the alumina, in part replacing the alumina and in part as an impurity only. The amount of iron is the commercial basis for classifying the ore as (1) light-colored or non-ferruginous bauxite, and (2) red or ferruginous bauxite, averaging from 10 to, in extreme cases, 50 per cent of iron oxide. Titanium dioxide is invariably present, ranging from 1 to 10 per cent. The bauxite deposits of County Antrim, Ireland, are extremely high in titanium, containing from 2.56 to 9.40 at Glenarm and as much as 11.06 at Tuftarney. Some of the bauxites of India show from 6 to 13 per cent of titanium dioxide. Chemical analyses of bauxites invariably show some silica, which varies from a fraction of one per cent to several per cent even in the purest ores; and from 30 to 40 per cent in the low-grade ores—bauxitic clays. The silica may be present in the form of the hydrated aluminum silicate (clay) or as free silica. Bauxite containing more than 15 per cent of silica is known as siliceous ore. In addition to those named, other common impurities are lime, magnesia, and phosphoric and carbonic acids. In some deposits rare impurities such as the alkalies soda and potash, amounting to scarcely more than a trace in each case, are found.

Definition

For practical purposes, therefore, bauxite may be defined as an ore which is a hydrated oxide of aluminum or a mixture of several hydrates, sufficiently pure to serve as a commercial source of aluminum or its salts.

Occurrence of Aluminum

Although aluminum is one of the most abundant elements of the earth's crust, being exceeded by oxygen and silicon alone, it is never found in the elementary form, but always in combination, as the oxide, hydrous oxide, fluoride, phosphate, sulphate, silicate, etc. The commonest form is the silicate, clay, which is one of the most stable compounds under the conditions prevailing at the earth's surface.

The chemical properties of aluminum are such that the oxide is comparatively rare. In combination with other compounds alumina (Al_2O_3) in the proportion of 15.02 per cent is a common constituent of igneous rocks, as determined by 1,252 analyses of such rocks in the laboratory of the United States Geological Survey. This proportion of alumina contains 7.96 per cent of the metal. Aluminum is an important constituent of all common rocks, except certain sedimentary ones, such as sandstone and limestone; and even in these its compounds are commonly present as accessories or impurities.

Association of Bauxite With Kaolin and Clay

One of the most striking characteristics of bauxite deposits is the close association of the ore with kaolin and common clay. It seems probable that most bauxite is altered kaolin or clay which has been derived by weathering from aluminous rocks. All the bauxite mined in the United States is closely associated with kaolin. In the Arkansas field the kaolin is derived from the surface alteration of the syenite in place. In the Tennessee and north Georgia and Alabama fields, the origin of the kaolin is not so clear, but it has been formed along faults, possibly by the action of circulating waters on the limestone, shale, and quartzitic rock of sedimentary origin. One author has ascribed these deposits to the alteration of the green bentonitic shales with which they are associated. In the central Georgia field the widespread sedimentary kaolins were deposited by Cretaceous and Tertiary streams which obtained the materials that they carried from the deeply-weathered crystalline rocks of the Piedmont region. The diaspore deposits of central Missouri are closely associated with the flint clays and are usually found in limited quantities in the same pit. The diaspore seems to be present in pockets in old limestone sink holes of the region. The material carries from 50 to 75 per cent aluminum oxide and thus has the highest alumina content of any ore produced in commercial quantities. The bauxitic clay and bauxite deposits of northwest Alabama (Colbert County), are closely associated with clays. The deposits are pockets and seem to be of Cretaceous age. The deposits of bauxite in northern and northeastern Mississippi (see page 88) are likewise closely associated with kaolins and impure clays. These deposits are interstratified with other beds of Eocene age and commonly grade upward or downward into kaolin or clay.

High Alumina Clays

Clays containing a large amount of alumina are known in many states, notably, central Pennsylvania, northeastern Kentucky, central Indiana, east-central Missouri, in the Cretaceous areas of Texas and Alabama, and in the West Coast states. These clays, so far as known, do not have the characteristics of American bauxite and are not sold as such, though the clay from some of the deposits is used in the manufacture of high alumina refractories.

Structure

Although it may vary in chemical composition, the bauxite in the United States, with the exception of the "granitic bauxite" of the Arkansas field, has a pisolitic structure; and the ore of the various areas is, on the whole, similar in general appearance. The pebble or pisolitic form is so general that it is the conspicuous characteristic of American ore. The pisolites, or pebble-like bodies, are set in a matrix, which may consist also of small rounded particles or may be so extremely fine-grained that it shows no evidence of granular texture.

The deposits of bauxite in North America, South America, Africa, Australia, and India lie practically horizontal and near the surface and can be mined by open cuts. Those in Europe, on the other hand, are inclined at angles high enough to carry them so deep that a part of the ore must be mined underground.

Output

The commercial output of bauxite, at the present time, is limited to North America, South America, and Europe. Most of the bauxite produced has been mined in France and the United States. Prior to 1914 Europe produced 60 per cent of the world's output of bauxite, and as high as 58 per cent of this amount was mined in France. Since 1914 the United States has produced more than half of the world's output of bauxite. The largest reserves, if the estimates given are correct, appear to be in the tropics, especially in Africa and South America.

Foreign Bauxite Deposits

INTRODUCTION

Some deposits of bauxite, bauxitic laterite, and bauxitic clay are found or reported to be found in each of the six continents. Europe has been the chief producer for many years, and most of the ore that has been mined has come from the famous deposits in France. Other deposits are in Germany, Great Britain, Hungary, Italy, Jugo-Slavia, Roumania, and Spain, and are reported in Russia. In South America there are extensive deposits in British Guiana, smaller deposits in Dutch and French Guiana, and reported deposits in Brazil and Venezuela. In Asia there are some rather extensive deposits of bauxite and bauxitic laterite in the Central Provinces of India. In Africa the largest deposits are in Gold Coast, although smaller deposits have been reported in Togoland, French Guiana, Kamerun, Rhodesia, Ashanti, and Union of South Africa. In Australia there are some deposits of low grade bauxitic laterite in New South Wales, Queensland, South Australia, and Western Australia.

EUROPE

Austria

The bauxite of Wochein, in the province of Styria, Austria, is dense and earthy, without nodular structure. On account of its unusual character it is given the distinctive name of wocheinite. The aluminum content is over 70 per cent in some analyses, but the iron oxide is also high, and the content of water is insufficient to form even the monohydrate.

The deposits in the former province of Istria are now controlled by Italy, and those of Dalmatia are held by Jugo-Slavia.

"It is reported that the bauxite deposits in Istria and Dalmatia, which were operated by the Austro-Hungarian Government during the war, produced 60,925 metric tons in 1915; 142,326 tons in 1916; 163,122 tons in 1917; and probably a larger quantity in the first ten months of 1918 than was produced in 1917. This bauxite was mined under military supervision and shipped to Germany. The article states that material carrying 44 per cent alumina was considered first quality ore."[1]

FRANCE

Bauxite received its name from the village of Baux, Bouches du Rhone, in Southern France, where it was originally discovered in 1821 by the famous chemist, Berthier. The Baux deposits were the first to be worked, and are, therefore, the most widely known deposits of the mineral. The French deposits have been extensively and almost continuously worked since 1872. As a result, the production from these deposits has been very great. Prior to 1914, Europe produced about 60 per cent of the world's output of bauxite, and as high as 58 per cent of this was mined in France. "Possibly 60 per cent of the bauxite reserves of Europe are in France."[2]

At Baux, Bouches du Rhone, the main bed of bauxite is 30 feet or more in thickness, highly ferriferous, and pisolitic. In both of the highly-inclined limbs of a large fold it lies on the eroded surface of the Urgonian (Cretaceous) limestone which forms the core of the fold. Above the bauxite on the north side of the anticline the stratigraphic sequence is as follows: a stratum of marly clay shale, a limestone containing large pisolites, a second bed of bauxite, a marly clay, a third bed of bauxite, a marly clay, a limestone containing Lychnus, and other younger beds. On the south side where part of the beds have been overturned, the stratigraphic succession above the main bed of bauxite is as follows: a marly clay, a second bed of bauxite, a limestone containing Lychnus, a limestone containing large pisolites, a limestone containing Lychnus, a yellow friable quartzose sandstone, a third bed of thin rose-colored bauxite separated by a fault from the adjacent Urgonian limestone of another fold.

Both the bauxite beds and the other beds associated with them are distinctly stratified and have the same characteristics as similar beds deposited in lacustrine or estuarine bodies of water. The geologists, Coquand and Auge, who have studied them in greatest detail, believe they represent the products of a Cretaceous lake or estuary.

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[1] Hill, James M., Bauxite and aluminum in 1920: U. S. Geol. Survey, Mineral Resources, 1920, pt. 1, p. 31, Washington, August 31, 1921.

[2] World atlas of commercial geology, part 1, Distribution of mineral production: U. S. Geol. Survey, p. 66, Washington, 1921.

The chief bauxite deposits of France are in the departments of Herault and Var. There are other deposits in the departments of Ariege and Pyrenees—Orientales, all in southern France, and Puy de Dome in central France. All these deposits except the ones in Puy de Dome belong to the Baux type; that is, they rest on a more or less deeply eroded surface of Lower Cretaceous limestone, and are interbedded with various lacustrine formations. The bauxite at Villeveyrac in Herault is white and contains a high percentage of aluminum oxide, but very little ferric oxide and silicon dioxide. It is used in the manufacture of aluminum salts. At Thoronet and Luc in Var the bauxite is dark red, presents the appearance of a fine homogeneous paste, and breaks with a splintery conchoidal fracture. The ore has been shipped to Germany, Italy, England, and America.

Average analyses of Var bauxite are given as follows:

	White variety	*Red variety*
Alumina	58 to 64	50 to 65
Ferric oxide	4 to 8	12 to 25
Silica	7 to 10	1 to 3

The following table gives analyses of some French Bauxites for the Departments of Bouches du Rhone, Var, and Herault:

Analyses of French Bauxite[3]

	1	2	3	4	5	6
Alumina (Al_2O_3)	57.60	55.40	30.30	33.20	69.30	76.90
Ferric oxide (Fe_2O_3)	25.30	24.80	34.90	48.80	a22.90	a.10
Silica (SiO_2)	2.80	4.80	----	2.00	.30	2.20
Titanium oxide (TiO_2)	3.10	3.20	----	1.60	3.40	4.00
Calcium carbonate ($CaCO_3$)	.40	.20	12.70	b5.80	----	----
Water	10.80	11.60	22.10	8.60	14.10	15.80
	100.00	100.00	100.00	100.00	110.00	99.00

a. Includes both ferrous and ferric oxide (FeO and Fe_2O_3).
b. Corundum.
1. Compact bauxite, no locality given.
2. Similar to 1, pisiform variety; d'Allauch near Marseille.
3. Hard and compact calcareous paste, Baux.
4. Calabres-Analyses 1-4, from M. H. Coquand, Sur les bauxites de la Chaine des Alpines (Bouches-du-Rhone) et leur age geologique: Bull. Soc. Geol. de France, 2d ser., vol. 28, 1870-1871, p. 101. M. H. Sainte-Claire Deville, analyst.
5. Red bauxite, Thoronet, Var.
6. White bauxite, Villeveyrac, Herault. Analyses 5-6 from M. Auge, Note sur la bauxite, son origine, son age, et son importance geologique: Bull. Soc. geol. de France, 3d ser., vol. 16, 1888, p. 345.

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[3] Phalen, W. C., Bauxite and aluminum in 1910. U. S. Geol. Survey, Mineral Resources, 1910, p. 716, 1911.

The geological relations of the red bauxite in Puy de Dome differ from those of the other French deposits, in that the ore rests on an eroded surface of gneiss and in the absence of limestone in the entire section. The bed ranges from 15 to 75 feet in thickness and is covered partly by Miocene clays and partly by a sheet of basalt.

Both Coquard and Auge ascribe the French deposits to the action of hot springs and geysers in lakes, in which the material was deposited along with other sediments.

"Prior to the war, some of the large deposits of high-grade bauxite in the Department of Var were controlled by the 'Bauxites de France', a German enterprise, but this control was naturally suspended at the beginning of hostilities, and it will probably not be resumed. The French bauxite industry is largely in the hands of the French producers of aluminum mentioned below, though some deposits are said to be controlled by the British Aluminum Co. through its control of the Union des Bauxites Company."

"The French aluminum industry is centralized under one selling agency, L'Aluminum Francaise, in which the following five companies participate:

"Compagnie des Produits Chemiques d'Alais et de la Camargne, Societe Electro-Metallurgique Francaise, Societe d' Electro Chemie, Societe des Forces Motrices de l'Arve, Societe Electro-Metallurgique de Pyrenees."[4]

By a decree of October 22, 1920, a duty of 20 per cent ad valorem was levied on bauxite exported from France. Apparently this duty affected the bauxite mining industry so seriously that it was repealed by a decree dated October 11, 1921. A review of the industry was published in Commerce Reports for December 19 ,1921.

GERMANY

In the Vogelsberg Mountains, Hesse, and near Konigswinter, in the lower Rhine region, Germany, low-grade bauxites have been mined; and deposits are also known in Hanover. The ore belongs to a wholly different type from that in France. Small masses of bauxite, fragments of weathered basalt, and iron ore are embedded in a gray or reddish-brown clay which shows unmistakable evidences of stratification in some places. The whole appears to be slightly rearranged residual material resulting from the alteration of basalt. That the bauxite unquestionably had the same origin as the clay in which it is embedded, seems to be proved by the presence in the ore of remains of the

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[4] Hill, J. M., Bauxite and Aluminum, Political and Commercial Geology and the World's Mineral Resources, Spurr, J. E., Editor, p. 353, New York, 1920.

minerals originally forming the basalt, and also of the characteristic basalt structure.

These deposits were considered of little economic importance, and had not been exploited prior to 1914. Before the war, some of the large deposits of high-grade bauxite in the Department of Var, France, were controlled by the "Bauxites de France", a German enterprise, but this control was suspended at the beginning of hostilities.

Analyses of German bauxite:[5]

From Wochein

Aluminum oxide (Al_2O_3)	64.24
Ferric oxide (Fe_2O_3)	2.40
Silicon dioxide (SiO_2)	6.29
Calcium oxide (CaO)	.85
Magnesium oxide (MgO)	.38
Sulfur trioxide (SO_3)	.20
Phosphorus pentoxide (P_2O_5)	.46
Water (H_2O)	25.74
(Analyst, Lill)	100.56

From Langsdorf[5]

(Analyst Lang)

	Brownish-red	Light red
Aluminum oxide (Al_2O_3)	50.85	49.02
Ferric oxide (Fe_2O_3)	14.36	12.90
Silicon dioxide (SiO_2)	5.14	10.27
Ferrous oxide (FeO)	.35	not det.
Calcium oxide (CaO)	.41	.62
Magnesium oxide (MgO)	.11	trace
Potassium oxide (K_2O)	.09	.11
Sodium oxide (Na_2O)	.17	.20
Water (ignition)	27.03	25.88
Water (100°)	1.35	.93
Carbon dioxide (CO_2)	trace	.26
Phosphate (P_2O_5)	.48	.38
	100.34	100.57

From Vogelsberg[5]

(Analyst, Liebreich)

Aluminum oxide (Al_2O_3)	50.92
Ferric oxide (Fe_2O_3)	15.70
Silicon dioxide (SiO_2)	1.10
Calcium oxide (CaO)	.80
Magnesium oxide (MgO)	.16
Water (ignition)	27.75
Water (100°)	.85
Titanium dioxide (TiO_2)	3.20
	100.48

The imported bauxite was refined, and a large quantity of the refined material was exported. Only a small amount

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[5] Packard, R. L., Aluminum in 1891: U. S. Geol. Survey, Mineral Resources, 1891, pp. 152, 153, 1893.

of aluminum was produced in Germany. During the war, the demand for aluminum in the manufacture of zeppelins, aeroplanes, and other things compelled the Germans to seek new sources of bauxite, and ore was obtained from Dalmatia and Hungary. At the same time the shortage of copper in Germany resulted in the extensive use of aluminum as a substitute. The consumption in 1904 was 2,000 tons, in 1913, 10,000 tons, and for the last year of the war it was estimated to be 32,000 tons. The total production of aluminum in Germany at the beginning of 1916 is estimated at about 600 tons a month. In the spring of 1917 it had risen to approximately 2,000 tons a month; and during 1918 it is estimated to have reached 2,500 tons a month, or about 30,000 tons a year. After the war, the output dropped to about 1,000 tons a month. It was reported recently that new plants erected since the war have a capacity of 10,000 tons. This brings the total producing capacity of the country up to approximately 40,000 tons a year.[6]

THE UNITED KINGDOM

Ireland

The bauxite deposits of Ireland furnish all of the ore produced in the United Kingdom. They are in the area lying north and northeast of Lough Neagh, between Belfast Lough and the north coast of County Antrim. The bauxite is associated with the pisolitic iron ores and laterites of the Interbasaltic beds and lies between two flows of basalt. Whereas many of the deposits seem to have originated from basalts, those at Glenarm and Straid Hill are associated with altered rhyolite or rhyolitic material. The presence of a group of seemingly stratified beds in the midst of the basaltic series of northern Ireland attracted the attention of the early visitors to the Giants Causeway. The bright red coloring of the zone halfway up the cliffs is in striking contrast to the brown and black joint-faces of the basaltic lavas. The upper series of basalts consists of massive columnar lavas and the lower series of thinner flows of lava. Seams of red or ochreous clay are found at various levels in the Lower Basaltic series.

Grenville A. J. Cole reaches the following general conclusions in regard to the interbasaltic zone:

"It is clear that the pisolitic iron ores, laterites, and bauxites of Ireland may have arisen from any rock exposed to conditions such as now prevail in tropical India or Africa,

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[6] Aluminum and bauxite, the mineral industry of the British Empire and Foreign Countries, War Period (1913-1919): Imp. Min. Res. Bureau, pp. 19, 20, London, 1921.

and that these conditions prevailed in Eocene or Oligocene times. F. P. Mennell states how laterite arises in Rhodesia on sandstone, limestone, granite, basalt, and various schists. J. B. Jukes, so far back as 1850, observed pisolitic ironstone developed on granite in Western Australia. G. C. Bauer, whose work on the Seychelles added so greatly to the interest of the question, also describes laterite derived from granite. It has even been suggested that a red- to cream-colored bauxite in Wilkinson County, Georgia, has arisen through the removal of silica from a bed of kaolin. Lithomarge passing into laterite occurs on rhyolite or granite in Mysore. H. B. Maufe shows how the red clay of East Africa arises from trachytes, which sometimes contrast strikingly with the superficial product, while at other times they are rotted and soft to a depth of twenty feet. Even in this laterite, titanium dioxide has characteristically accumulated until it forms as much as 3.12 per cent of the clay. In the pale bauxite of Ballintoy (analysis III.) it amounts to 5.20 per cent, and in that of Glenarm (analysis XIV. to XVII.) it runs from 2.56 to 9.40 per cent. The Glenarm bauxites are believed to have a rhyolitic origin, and the titanium may originally have been present in rutile.

"The derivation of bauxite from basic igneous rocks has been abundantly proved, as in the Westerwald, the Vogelsberg, India, British Guiana, and elsewhere. When a pale material has resulted in such cases, as at Tuftarney in the county of Antrim, it has been suggested that water from overlying plant-beds has leached away the iron. The titanium dioxide is believed to have become concentrated in these basic cases from ilmenite in the parent rock. One analysis of the Tuftarney product (analysis XXXXIV.) shows 11.06 per cent. The small percentage of iron in some of these examples suggests that the titanium dioxide, whatever its origin, is now present as rutile, a condition in which it occurs in many argillaceous rocks.

"The typical downward succession in the county of Antrim is (3) pisolitic iron ore; (2) 'pavement' (a material varying from a siliceous iron ore to a lithomarge, with a false appearance of stratification, due to coloured streaks connected with the decomposition of residual blocks of basalt) ; (1) lithomarge (decomposed basalt retaining the original joint-structure and often showing pseudomorphs after the felspars of the ground-mass). Lithomarge may consist largely of kaolin; but in Ireland it passes into ferruginous bauxite, and its silica percentage represents silicates not completely decomposed. This passes down into a basic lava of the Lower Basaltic series. Pisolitic grains have been formed by concretion within the rock-mass even on this low horizon, and in places where red bole and basalt are closely intermingled.

"The pale bauxites derived from rhyolite, as at Glenarm and Straid, overlie the pisolitic iron ore when they occur. At Straid, rhyolitic flows may have decomposed, under laterising conditions, in situ. In other places the rhyolitic matter is clearly detrital, and has been washed down as mud over a lowland, or has been transported, as a fine dust mingled with quartz grains, by wind. The occurrence of rhyolitic tuffs at Sandy Braes shows that some of this material may have been fragmental at the outset. The laterites and lithomarges of north-eastern Ireland, that is, the main mass of the interbasaltic zone, cannot, however, be connected either with volcanic explosions or with accumulation in lakes, but must be regarded as typical examples of soils and subsoils formed under conditions now prevalent in regions of seasonal rains, nearer the equator."[7]

From numerous analyses of bauxite given in "The Interbasaltic Rocks (iron ores and bauxites) of north-east Ireland" (1912), the siliceous character of the ore is shown. There are several exceptions, however, notably in the material from near Ballynure, at which deposit the content of silica is about 9 per cent. As a result of its siliceous nature most of the Irish bauxite has been used in the manufacture of aluminum sulphate, although some has been used in the manufacture of aluminum. The mining of bauxite as "alum clay" began in 1873. The amount of titanium dioxide in the bauxite is rather high, varying from 2.56 to 9.40 at Glenarm, and reaching 11.06 at Tuftarney.

The principal bauxite localities in County Antrim are in Clegnagh west of Ballintoy, Essathohan, Tuftarney, Glenarm, and Irish Hill.

Clegnagh, west of Ballintoy, contains deposits of pale gray bauxite which is commonly pisolitic.

Essathohan, one mile north of Parkmore railway station, where some bauxite was mined, contains deposits consisting of lenses averaging 120 to 150 feet in width and, at most, 2 feet to 2.5 feet in thickness. No iron ore was found; and the mining of bauxite was abandoned because the material was too ferruginous.

Tuftarney, between Newton Crommelin and Cargan, contains bauxitic deposits consisting largely of dark and light bluish-gray material, having a low specific gravity and re-

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[7] Cole, Grenville A. J., and others, The interbasaltic rocks (iron ores and bauxites) of northeast Ireland: Memoirs, Geological Survey of Ireland, pp. 14, 15, Dublin, 1912.

sembling lithomarge in touch, general appearance, and readiness to crumble on exposure.

Analyses of Deposit, Tuftarney Hill[8]

	White portion (Analyst, D. S. Jordan)	*Blue-gray portion* (Analyst, W. D. Haigh)
Moisture (free), lost at 110°C	5.04	4.64
Moisture (combined)	13.78	17.72
Silica	42.54	27.93
Ferric oxide	0.60	2.03
Alumina	34.56	41.32
Titanium dioxide	3.75	5.46
Lime	Trace	.60
Magnesia	0.00	.25
	100.27	99.95

Libbert Mine, Glenarm, contains gray bauxite which was probably derived from rhyolite. The material is no longer exposed.

Section at Libbert Bauxite Mine in 1879[8]

Upper Basalt, black and compact.

Interbasaltic beds have a thickness of 30 feet.

Lignite.

Bauxite, gray.

Whitish, gray, and variegated laminated rhyolitic clay, shale, marl, sandy beds, and pebbly rhyolitic conglomerates.

Whitish and gray fine-grained laminated rhyolitic clay and shaly beds with plant remains.

Lower Basalt, amygdaloidal, about 300 feet thick over the chalk.

Irish Hill and Straid, east of Ballynure and northeast of Ballyclare, contain gray rhyolitic and bauxitic beds. The quality of the ore is shown by the following analyses:[8]

	First Quality	*Second Quality*	*Third Quality*
Silica	8.67	12.00	10.40
Titanium dioxide	5.80	6.20	4.20
Alumina	53.83	52.00	46.13
Iron peroxide	1.57	4.57	15.14
Magnesia	.13	.20	.26
Lime	.62	.79	.18
Potash	.01	.02	.04
Soda	.00	.06	.24
Combined water	29.27	24.00	23.39
Sulphur trioxide	.07	.07	.10
Phosphorous pentoxide	Trace	Trace	Trace
	99.97	99.91	100.08
Moisture lost on drying at 100°	7.50	.90	.85

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[8] Cole, Grenville, A. J., and others, The interbasaltic rocks (iron ores and bauxites) of northeast Ireland: Memoirs, Geological Survey of Ireland, pp. 14, 15, Dublin, 1912.

The bauxite is probably derived from rhyolite and in places overlies pisolitic iron-ore; both are preserved under an outlier of Upper Basalt.

Bauxite has also been mined at the iron mines of Cargan, Evishacrow, and Correen; and at Cullinane, 2½ miles south-southwest of Carnlough.

In the county of Londonberry, a brown-gray bauxite has been mined at Killygreen, four miles south-southeast of Portrush.

Scotland

The deposits of bauxitic clay are in the southern part of Scotland in northern Ayrshire. The main outcrop of the bauxitic clay has been traced almost continuously for 15 miles from Saltcoats, South Bay, east to Fenwick Water near Kilmarnock. The bed usually forms a definite horizon, but in a few places it is either very thin or absent. These deposits of bauxitic clay are closely associated with the lava flows of the Millstone Grit series.

According to G. V. Wilson, the Millstone Grit series in the northern part of the Ayrshire Coalfield differs in many respects from rocks of the same age in other parts of Great Britain. The main difference is the presence in Ayrshire of contemporaneous volcanic beds, which consist of several basaltic lava flows and beds of ashes. Other members of the series are important because they contain valuable beds of fire clay.

The general section of the Ayrshire Millstone Grit Series is as follows:[9]

	Feet
Ayrshire bauxitic clay	0-30
Lava (rotten and often lateritized to inferior iron ore)	3-6
Red mudstone	0-2
Lava flows with occasional interbedded sediments	30-300
Sediments (mainly fireclay)	-30
Sandstone	-20
Sediments mainly blues with occasional calcareous fossiliferous bands	-30

"The thickness of the volcanic group and the number of lava flows vary considerably, but at nearly all those examined the group either passes up insensibly into, or is directly overlain by, the Ayrshire Bauxitic Clay. In one or two instances similar bauxitic beds have also been found inter-

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[9] Wilson, G. V., The Ayrshire bauxitic clay: Memoirs, Geological Survey, Scotland, Edinburgh, 1922.

bedded in the underlying volcanic group, as, for example, in the Glen Burn. In some localities the lower flows are fresh and in good preservation, but the upper ones are almost always highly decomposed, and converted in material which is rich in iron oxide. Sometimes this enrichment has affected the whole lava flow in the same manner from top to bottom, and at other times the enriched portions are either in the form of irregular masses or of thin veins of ferruginous matter scattered through a more argillaceous (bauxitic) matrix."[10]

No estimates of the available reserves have been made. The reserves are probably large, however, especially if the deposit extends beneath the worked coalfield to the south of the outcrops.

The color of the bauxitic clay varies from light to dark gray, but yellowish, brownish, dark mottled, and black varieties are found. In hardness the clay varies from that of a compact limestone to that of a calcareous shale; and there is no general tendency for the harder beds to be localized at the top of the deposit. The fracture is commonly conchoidal. The texture is extremely variable. Some of the clay is even-grained and uniform; some presents features of an ordinary fire clay, that is, being without bedding planes and containing rootlet stains. It may retain some of the structure of the parent rock, which may have been a lava flow, a volcanic ash, or a carbonaceous deposit. Where formed from carbonaceous material, the bauxitic clay is compact, hard, exceedingly brittle, black and has a velvety lustre on a newly fractured surface. In other instances the clay is a detrital deposit, formed practically in situ, possibly as a soil, or as sediment in shallow lagoons. The lagoon deposits show a prevailing oolitic or even pisolitic structure, and the individual grains vary from microscopic dimensions to a quarter of an inch or more in diameter.

According to Wilson, "the material shows promise of being useful in the manufacture of common alum. For this purpose the varieties with low iron content are preferred. It has been suggested that the more aluminous varieties might be used for the manufacture of aluminum. So far this has not been possible, owing to the fact that the bulk of the alumina is combined as silicate, and so not separable by the means used for the preparation of pure alumina from ordinary bauxite.

"Probably the future of the deposit lies mainly in its use as a refractory. The highest-grade material is perhaps not

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[10] *Op cit.*

present in very large quantities. Of inferior grade with refractory quality of Seger cone 30-31 there is abundance."[11]

The bauxitic clay is used by a number of companies in the manufacture of bricks for electric steel furnaces and of other articles which must resist the very high temperatures attained in modern metallurgical work. During the war the demand for the clay continued; and its special qualities enabled British manufacturers to provide substitutes for certain classes of refractories formerly obtained from Germany and other foreign countries.

Refined alumina is produced in the United Kingdom at Larne Harbor in Antrim County, at Burntisland in Fifeshire, and at Hebburn near Newcastle-on-Tyne. There are aluminum reduction works at Foyers in Invernesshire, Kinlochleven in Argyllshire, and Dolgarrog in North Wales. The British Aluminum Company controls the deposits in Ireland, and is the sole producer of aluminum in England.

References

Wilson, G. V., The Ayrshire bauxitic clay: Memoirs, Geological Survey Scotland, Edinburgh, 1922.

Mining Journal (London), Feb. 7, 1920.

HUNGARY

The bauxite deposits of West Hungary are in the Vertes and Bakony Mountains: "Where on the basis of transgressional Eocene thick layers of bauxite are to be found and were formerly mentioned as 'tertiary terra rossa and laterite' by H. Taeger in his report: Die geologischen Verhaltnisse des Vertesgebirges: Mitterlungen aue dem Jahrbuche d. kgl. ung. geol. Anstalt, Bd. XVII, p. 108, Budapest. These layers were recognized only a few years ago as bauxite with 47-50 per cent rarely 62 per cent Al_2O_3, but also as to be available only partially. Reports on this occurrence have not been issued."[12]

"It is reported that a large deposit of bauxite has been found in the Bakony district, Hungary, near the railroad between Veszprem and Deveczer, which will be developed by the Tapolcaer Mining Co., of Budapest."[13]

The deposits in the Bihar Mountains are occupied by Roumanians at the present time. Recent reports on these deposits are:

P. Rozlozsnik: Vorlaufiger Bericht uber die Art des Auf

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[11] *Op. cit.*

[12] Letter from State Geologist, March 17, 1923.

[13] Hill, James M., Bauxite and aluminum in 1921: U. S. Geol. Survey, Mineral Resources, 1921, pt. 1, p. 67, Washington, August 1, 1922.

tretens der Bauxite in nordlichen Bihar Jahresbericht d. kgl. ung. geolog. Anstalt fur 1916, p. 506.

F. Beyschlag: Neuere Boebachtungen an den Bauxitlagerstatten des Biharbebirges in Ungarn. Krahmann Zeitschr. fur praktische Geologie, Bd. XXVI. p. 35. Stuttgart, 1918.

Finkey J. & Jakoby I.: an article on Hungarian bauxite-ore mines only in Hungarian language all with quotations of former literature.

ITALY

The bauxite deposits are found in the Apennine Mountains in the south-central part of Italy. They are of Cretaceous age and are similar to those in France, but are smaller and of lower grade. Bauxite has been produced since 1907; see table of world's production, p. __

"Recent researches of Matticolo and analyses by Formenti have, however, proved the presence of notable surface deposits (1,000,000 sq. metres of a thickness of 3 metres) at Lecce nei Marzi on the slope of Monte Turchio. This bauxite contains 50 to 55 per cent of aluminum and 3 to 4 per cent of silica (SiO_2), but the contents of iron sometimes exceed 25 per cent of Fe_2O_3, and this explains how the Engineers of the Bureau of Mines erroneously classified these minerals as iron ores. They are now the property of the 'Societa italiana per la fabbricazione di alluminio', who treat and purify these ores in their works at Bussi."[14]

According to Hill, "the bauxite deposits of the newly acquired Italian Provinces of Dalmatia and Istria, described in 1920, have proved of considerable economic importance; and it is known that bauxite from these mines has been offered in the United States."[15]

"Some very valuable deposits of bauxite occur in Italy in the neighborhood of Abruzzi and Tamnium. It has been reported that the Italian Government intended purchasing these deposits in connection with the electrification of the railways, for which a large quantity of copper would be required unless aluminum were available. As Italy would be obliged to import copper, she is likely to substitute aluminum for it as far as possible. The increase in output is chiefly owing to larger production from Lesci dei Marsi. Of the 8,744 long tons of bauxite produced in 1916, 7,419 were treated with caustic soda at the works of a company manu-

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[14] Molinari, Dr. Ettore, General and Industrial Organic Chemistry, Translation of 3d edition, p. 571, 1912.

[15] Hill, James M., Bauxite and Aluminum in 1921: U. S. Geol. Survey, Mineral Resources, 1921, Pt. 1, p. 67, Washington, August, 1922.

facturing aluminum at Bussi-sul-Tirino. This bauxite with a lesser quantity of natural and artificial cryolite and 12 tons of other alumina, yielded 1,108 tons of the metal, valued at £495,440.

"Scarcely any aluminum, ingot or manufactured, is exported from Italy."[16]

The principal deposits in Dalmatia lie near Lesina and Dernis. At Lesnia there are several deposits which are in red limestone. The deposits at Dernis extend for nine miles along a belt of limestone. They are connected by rail with the port of Sebenico and were worked in 1918 for the German trade.

The bauxite deposits of Croatia are in the Velebit Mountains.

"According to a recent report (Mining Journal, 19th February, 1921) the total outputs of bauxite in Dalmatia and Istria for 1915, 1916, and 1917 were 59,946 tons, 140,038 tons, and 160,501 tons, respectively."[17] The unofficial report for 1918 was 164,600 metric tons.

JUGO-SLAVIA

The bauxite deposits are in Dalmatia on both sides of the lower stretches of the River Kerka, in part of the Zagorge, and on the central Dalmatian Islands. Other deposits are at Rammljane in the centre of Mosec plain, near Blaca and Konjsko north of Clissa, and at Kalun.

Analyses of Dalmatian bauxite:[18]

	No. 1	No. 2
Alumina	57.9	57.5
Silica	1.2	2.2
Ferric oxide	24.3	24.1
Lime	0.3	---
Titanium dioxide	4.2	3.8
Combined water	12.0	12.0
Moisture	0.4	0.6

The deposits of Dalmatia, Croatia, and Istria have been divided between different countries as a result of the World War. They have been discussed under Italy.

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[16] Aluminum and bauxite, The mineral industry of the British Empire and Foreign Countries, War Period (1913-1919): Imp. Min. Res. Bureau, p. 21, London, 1921.

[17] *Op. cit.*

[18] Aluminum and bauxite, the mineral industry of the British Empire, War Period (1913-1919): Imp. Min. Res. Bureau, p. 21, London, 1921.

NORWAY

"All of the bauxite used by the aluminum works in Norway is of French or British origin. There are no deposits of bauxite in the country. The British Aluminum Company controls the aluminum plants at Higeland and Strangfiord through the Anglo-Norwegian Co. The Compagnie des Produits Chemiques d'Alais et de la Camargne (French) largely controls the Societe Norvegienne des Nitrures, which operates aluminum works at Arendal and Tyssedal. A Norwegian company, the Norske Aluminum Co., has been recently organized to make aluminum."[19]

"It is reported that more or less successful attempts have been made by the Norsh Electrochemick Co. of Norway to extract alumina from labradorite by treatment with nitric acid. The work is progressing, and it is stated that a plant for handling labradorite on a commercial scale is being built. The works of the Hoyang-Faldene Co. are to be pushed to completion, and the electrode, carbide, and iron producing equipment has been in operation."[20]

ROUMANIA

"The bauxite deposits of the Bihar Mountains in Roumania were discovered only a few years ago, and were not exploited until the war, at which time they were owned by Hungary. The development of the deposits was undertaken chiefly by the Bihar municipality to supply the demand of the German aluminum trade. The bauxite of this region is associated with limestones of Jurassic age, and forms extensive deposits.

"At Fata Oarza there is an outcrop of bauxite, but transportation is as yet difficult, as there are no good roads.

"The grey and red bauxites of the Bihar mountains show the following composition:

	Gray variety	*Red variety*
Alumina	69	55.6
Silica	12	3.0
Ferric oxide	3	25.3
Water	15	11.0

Both varieties contain from 3 to 4 per cent of titanium dioxide. They occur sometimes together and sometimes separately.

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[19] Hill, James M., Bauxite and aluminum, Political and Commercial geology and the World's Mineral resources, J. E. Spurr, Editor, pp. 353, 354, New York, 1920.

[20] Hill, James M., Bauxite and aluminum in 1919: U. S. Geol. Survey, Mineral Resources, 1919, Pt. 1, p. 39, Washington, August 30, 1920.

"It has been estimated that the visible deposits in the Bihar district will yield from two to ten million tons of ore, while there is a possible reserve of another ten to twenty million tons. The deposits have been worked since 1915, and all the output has been exported to Germany.

"In 1915, there was an output of 58,118 tons, valued at £29,509; and in 1916 the production is said to have been even greater.

"The undertaking is in the hands of the Graf Kosniss Trust, to which the Jadtal Aluminum Mining Company and the Vaskoher Iron and Aluminum Mining Company also belong. The works of the first-named company are near Baratka, Elesd, Kalota, and Jadremete, and those of the latter near Rev and Bihardobrosd (Bihar district).

"During the war the German factories were dependent upon these and the Dalmatian deposits for their raw material. The ores yield from 25 to 30 per cent aluminum."[21]

RUSSIA

"It is reported that in 1911 Russia exported 26,200 tons of bauxite, which was probably mined near Borovitchi, in Novgorod, 200 miles southeast of Petrograd."[22]

SPAIN

The bauxite deposits in Spain lie along the coast from Barcelona to Cadiz. The ore in the Provinces of Barcelona and Tarragona was found about 1918 and is reported to be associated with Triassic rocks. The deposits in Barcelona Province were opened in 1918 and made an initial production of 453 long tons. Bauxite deposits in Catalina also have been described, but apparently are not productive.[23] The ores produced 453 long tons in 1918 and 1,751 long tons in 1919, according to the report on The Mineral Industry of the British Empire.

SWITZERLAND

Bauxite is not found in Switzerland, but the manufacture of aluminum is an important growing industry. The material treated formerly was calcined alumina, which was im-

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[21] Aluminum and bauxite, the mineral industry of the British Empire, War Period (1913-1919): Imp. Min. Res. Bureau, pp. 21, 22, London, 1921.

[22] World atlas of commercial geology, part 1, Distribution of mineral production: U. S. Geol. Survey, p. 66, Washington, 1921.

[23] Gatatayad, J. E. N., Las Bauxitas de Catalina: Real Aca. de ciencias exactas Revista, vol. 17, 2d series, pp. 422-470, Madrid, 1919.

ported from France before the war. During the war the raw material was obtained from Austria-Hungary.

"Apparently most of the aluminum industry of these countries (Central Powers) is controlled by a German-Swiss company, Societe Swisse pour l' Industrie de l' aluminum, or Aluminum Industrie, A. G., which operates plants at Neuhausen, Chippes, Navisance, and Borgne in Switzerland; at Rheinfelden, Germany; and at Lend and Rauris, in Austria."[24]

"Prior to the war almost all of the unwrought aluminum exported from Switzerland went to Germany, and from 1915 onward Germany took practically the whole of the exports."[25]

Imports of Aluminum into Switzerland[26]

Year—	*Quantity (long tons)*	*Value** (£)
1913	590	78,645
1914	406	59,771
1915	121	20,914
1916	189	38,673
1917	435	100,241
1918	371	79,022

Exports of Aluminum from Switzerland[27]

Year—	*Quantity (long tons)*	*Value** (£)
1913	7,367	538,276
1914	7,351	595,139
1915	9,262	1,496,033
1916	11,192	1,978,460
1917	10,952	2,259,357
1918	11,187	2,534,613
1919	6,000	1,320,000

*Values converted to £ sterling at the rate of 25 francs=£1.

SOUTH AMERICA

Brazil

"It is reported that bauxite has been discovered in Para River, presumably in northeastern Brazil; and highly aluminous material is found in the lateritic iron deposits in Minas Geraes."[28]

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[24] Hill, James M., Bauxite and Aluminum, Political and commercial geology and the World's mineral resources, J. E. Spurr, Editor, p. 354, New York, 1920.

[25] Aluminum and bauxite, the mineral industry of the British Empire, War Period (1913-1919): Imp. Min. Res. Bureau, pp. 22, 23, London, 1921.

[26] *Op. cit.*

[27] *Op. cit.*

[28] Hill, James M., Bauxite and aluminum in 1918, U. S. Geol. Survey, Mineral Resources 1918, Pt. 1, p. 521, Washington, March 16, 1920.

British Guiana

The bauxite deposits of British Guiana[29] extend from Yarikita in the northwestern part of the colony near the Venezuelan boundary to Ituni Creek in Berbice, near the Dutch Guiana boundary, a distance as the crow flies of 220 miles. Deposits of bauxite are reported also from points on the Berbice and Courantyne rivers. The fact that high grade bauxite has been found in quantity at Plantation Onoribo on the Para River, a tributary of the Surinam river, as well as at Porto Rico or Rac-a-Rac on the Surinam river, and in the vicinity of the Coermatibo river, a tributary of the Cotica river; and the fact also that it was discovered many years ago (about 1878) at the Crique Boulanger in French Guiana, render it probable that deposits of ore are to be found along the Berbice and Courantyne rivers.

Deposits may be discovered after careful prospecting on the northern frontage of the foothills of the Archean complex on such rivers as the Barima, Barama, Waini, Pomeroon, Berbice, and Courantyne. Present knowledge indicates that the Guianas or at least British and Dutch Guiana contain some very extensive deposits of concretionary amorphous bauxite and possibly contain others consisting to a great extent of crystalline gibbsite derived from the alteration of the rock in situ (e. g. Yarikita). The bauxites along the foothills are found at various places across British and Dutch Guiana for a distance of 400 miles.

The largest deposits in British Guiana are in the Christianburg-Akyma district of the Demerara river. Christianburg is 58 miles south of Georgetown on the Demerara river, near the head of navigation. The deposits extend along both banks of the Demerara River from Plantation Christianburg on the north to Akyma and Kumara in the south, a distance of 10 miles. At places deposits in this District have a great thickness, those at Three Friends and Akyma showing possibly 30 to 40 feet of ore. The river flows through the area; and at several places the beds of bauxite cross it, forming shallows. The beds extend both east and west from the Demerara River for a considerable distance. The bauxite varies considerably as to quality. In some places it contains 67 per cent of aluminum oxide when dried, of which 65 per cent is in the form of hydrate; in others the ore is a ferruginous bauxite or laterite which may not contain more than 40 to 44 per cent of aluminum oxide as hydrate with 4 to 8 per cent of kaolin and from 25 to 28 per cent of limonite

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[29] Reports and correspondence relative to bauxite in British Guiana, 1910 to 1917: British Guiana, Combined Court, second special session, 1917, 31 pp., Georgetown, Demerara, 1919.

and other iron-ores. The titanium dioxide varies in the different deposits from less than one per cent to nearly 6 per cent.

The bauxite at Christianburg is in the form of gravel or pebble ore and layers varying from 6 to 18 inches in thickness, which are interstratified with white to ochreous-colored sticky clays. The low rounded hills are covered by a layer of sandy clay of variable thickness, the surface portion of the mounds being quartz sand which contains vegetable debris. The lower layers of bauxite are commonly red as a result of the presence of iron oxide. The deposits are exposed along small streams which have cut through the sandy material above into the underlying hard bauxite.

Nine samples of bauxite from Akyma, on the Demerara River, showed the following average composition:[30]

Alumina	59.56
Silica	2.65
Ferric oxide	2.49
Titanium dioxide	3.80
Combined water	30.39
Moisture	1.11
	100.0

The range in composition of the nine samples is indicated by the maximum and minimum percentages of the different chemical constituents, determined to be as follows:

	Maximum	*Minimum*
Alumina	61.08	57.30
Silica	4.58	1.07
Ferric oxide	3.35	1.30
Titanium dioxide	4.84	2.00
Combined water	31.62	27.86
Moisture	3.88	0.54

Harrison says that, "some specimens of bauxite from Christianburg, Demerara River, show under the microscope a somewhat obscure structure suggesting that, in parts at least, it has been formed in situ by the lateritisation of a porphyrite, a porphyroid or possibly a metamorphosed tuff. Similar indications of an original rock-structure were noticed in one of the specimens obtained from the Ituni Creek, Berbice River."[31]

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[30] Aluminum and bauxite, the mineral industry of the British Empire and Foreign Countries, War Period (1913-1919): Imp. Min. Res. Bureau, p. 15, London, 1921.

[31] Harrison, J. B., Reports and correspondence relative to bauxite in British Guiana, 1910-1917: British Guiana, Combined Court, second special session, 1917, 31 pp., Georgetown, Demerara, 1919.

According to J. B. Harrison, "nothing is known regarding the areas occupied by bauxite at Yarikita, North West District; Arawaii, Essequebo River; and the Ituni creek, Berbice river."[32]

The last named place is probably an extension of the Christianburg-Akyma area. Some of the deposits were formerly described as "reddish-white friable pisolitic rock", before they were known to be bauxite.

"The mean compositions of the various samples of British Guiana bauxite which I have examined during the past few years are shown in Table XXI. The analyses with one exception may be accepted as fairly representative of the varying compositions of the deposits. The exception is that from Hahauria Creek which consists of pebbles of "float" bauxite encased in a ferruginous sandstone; the source of this very high grade bauxite has not been ascertained."[33]

The deposit of high-grade bauxite near Yarikita Hill on the Amacura River in the North-West District consists of crystalline gibbsite. According to J. B. Harrison it seems to have been derived in situ from a muscovite-bearing pegmatite or aplite. "The rock may have been one of those fairly common in British Guiana in which the feldspars present are calcic plagioclases, whilst it may have been an aplitic or anorthosite phase in the ancient gabbro now metamorphosed to epidiorite or to hornblende-schist which is the prevalent rock in its vicinity."[34]

In 1916 J. B. Harrison stated in his "Memorandum on the occurrence of bauxite in British Guiana" that, "applications have been received by the Department of Lands and Mines for permission to mine or quarry bauxite over 22,045 acres in the Demerara and Essequibo Rivers district; whilst Mr. W. C. Neilson, on behalf of the Companies he represents, has purchased either the land of or the right to mine bauxite on some twenty abandoned plantations in the Christianburg-Akyma district of the Demerara River, this area being in excess of 22,180 acres."[35]

At some date after June 26, 1917, J. B. Harrison stated that, "at date 274 applications comprising an aggregate area of 2,154,635 acres have been filed for leases. All applicants have been informed by direction of the Secretary of State for the Colonies that no concessions for mining bauxite will be made or promised until after the War when the whole

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[32] *Op. cit.*
[33] *Op. cit.*
[34] *Op. cit.*
[35] *Op. cit.*

question will be considered in connection with the subjects of Imperial Trade and Defence."[36]

The first shipments of bauxite were made in 1917, when 800 men were employed and 2,037 long tons were produced, all of which was exported to the United States. The Demerara Bauxite Company operated the Three Friends deposits and paid the Government a royalty of 10 cents per ton. "During 1918, 4,199 tons of ore were shipped. During 1919, stocks appear to have been accumulating, and there were no shipments that year; but during 1920, the exports amounted to 29,399 tons, bringing the total quantity shipped since mining operations were begun up to 35,635 tons."[37] No bauxite was mined during 1921 or 1922; however, the Aluminum Company of America expected to resume operations on their holdings in January, 1923.

"It is reported that the Aluminum Company of America controls 2,030,000 acres of bauxite land in the British and Dutch colonies. In British Guiana the ownership is seemingly in the Canadian Bauxite Company. Associated with the Aluminum Company of America in the British Guiana holdings is the Merrimac Chemical Company of Boston."[38]

"Morrison and Sons of London and the British Aluminum Makers have organized a bauxite mining company, which is reported to have been given a concession for all the bauxite along Demerara River, British Guiana, not controlled by the Demerara Bauxite Company. This is presumably the company, whose formation was brought about by the British Government in order to control the bauxite of this colony."[39]

"It is reported that England has placed certain restrictions on the acquisition of bauxite deposits in India and Guiana by foreign individuals or corporations. It is known that she has restricted the destination of bauxite exported from British Guiana."[40]

British Guiana

Reports and correspondence relative to bauxite in British Guiana, 1910 to 1917.

British Guiana, Combined Court, Second special session 1917, 31 pp., Georgetown, Demerara, 1919.

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[36] *Op. cit.*

[37] *Op. cit.*

[38] Hill, James M., Bauxite and aluminum, Political and commercial geology and the World's mineral resources, J. E. Spurr, Editor, p. 353, New York, 1920.

[39] Hill, James M., Bauxite and aluminum in 1921: U. S. Geol. Survey, Mineral resources, 1921, Pt. 1, p. 67, Washington, 1922.

[40] Hill, James M., Bauxite and aluminum, Political and commercial geology and the World's mineral resources, J. E. Spurr, Editor, p. 351, New York, 1920.

This paper includes a number of reports and a memorandum on the occurrence of bauxite in British Guiana by J. B. Harrison.

Aluminum and Bauxite, the mineral industry of the British Empire and Foreign Countries, War Period (1913-1919), pp. 14, 15, London, 1921.

Emory, L. T., British Guiana: Eng. and Min. Jour., vol. 3, p. 363, 1921.

Reports on the Lands and Mines Department, British Guiana (Annual).

Dutch Guiana

The Surinam bauxite deposits are present at places from the vicinity of the Onoribo hills on the west bank of Para Creek, a tributary of the Surinam River, to the area of the Coermatibo River, a tributary of the Cotica River. Deposits are known at Porto Rico or Rac-a-Rac on the Surinam River. Bauxite deposits have been found in the vicinity of the Saramacca River and are reported to have been acquired by American interests. In both Dutch and British Guiana the bauxite deposits are along the northern frontage of the foothills of the Archean complex.

The following analysis shows the quality of the ore on Para Creek:

Bauxite from Onoribo, Para Creek, Surinam River, Dutch Guiana[41]

	Quartz and chalcedony	.3
(1)	Combined silica	1.2
	Iron peroxide	1.2
	Titanium dioxide	.9
(2)	Aluminum oxide	64.6
	Magnesium and calcium oxide	Traces
	Water	31.8
		100.0
(1)	Equal to kaolin	2.7
(2)	Aluminum oxide in bauxite	63.5

"Deposits of bauxite have been found in the eastern part of Dutch Guiana on the Surinam River, and have been opened out on Para Creek, Rena Reu Creek, and Marechals Branch, all tributary to the Surinam River, and also on the Cotica River. The area covered by these deposits is 62 miles long and 62 miles wide.

"Hitherto, however, there appears to have been little or no production. The output for 1919 is reported to have been 1,500 pounds valued at $6.00."[42]

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[41] Harrison, J. B., Memorandum on the occurrence of bauxite in British Guiana: Combined Court, Second special session 1917, Reports and correspondence relative to bauxite in British Guiana, 1910 to 1917, p. 19, Georgetown, Demerara, 1919.

[42] Aluminum and bauxite: the mineral industry of the British Empire and Foreign Countries, War Period (1913-1919) Imp. Min. Res. Bureau, p. 26, London, 1921.

Quoting from Hill: "The Dutch have made provision, under the law of March 27, 1919, as amended November 24, 1919, for the holding and operation of bauxite lands in Dutch Guiana. Only inhabitants of The Netherlands or Suriname or Companies established in either place are permitted to hold or operate concessions."[43]

Again quoting from Hill: "In Surinam, Dutch Guiana, the Surinaamsche Bauxite Maatschappy has constructed a bauxite drying and dockage equipment at Moenge, 100 miles above Paramaribo, on Surinam River. All operations were suspended during 1921, owing to unsettled conditions in the bauxite industry. The bauxite deposits have been described in two articles (in Dutch), one by Douglas, which is a general account of the utilization and occurrence of bauxite, with incidental mention of the Dutch deposits, and the other by Dentz which deals rather with the organization of the work than with the geology or the development of the deposits, and contains some photographs of the camp and the deposits."[44]

"It is reported that the Norton Company, of Worcester, Mass., has acquired in Dutch Guiana small holdings of bauxite lands. There are no works utilizing bauxite in Dutch Guiana."[45]

French Guiana

Bauxite was discovered many years ago (about 1878) in the vicinity of the Crique Boulanger in French Guiana. Where the mountains are near the sea the foothill area in which the bauxite deposits are usually found in the Guianas is a rather narrow belt.

"It is reported that the Guiana Development Company has sent a corps of engineers to develop its property on Marowine River in French Guiana."[46]

Venezuela

"It is reported that there are evidences of bauxite in eastern Venezuela."[47]

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[43] Hill, James M., Bauxite and aluminum in 1920, U. S. Geol. Survey, Mineral resources, 1920, Pt. 1, p. 33, Washington, August 31, 1921.

[44] *Op. cit.*

[45] Hill, James M., Bauxite and Aluminum, Political and commercial geology and the World's mineral resources, J. E. Spurr, Editor, p. 353, New York, 1920.

[46] Hill, James M., Bauxite and aluminum in 1921, U. S. Geol. Survey, Mineral resources, 1921, Pt. 1, p. 68, Washington, August 1, 1922.

[47] Hill, James M., Bauxite and aluminum, Political and commercial geology and the World's mineral resources, J. E. Spurr, Editor, p. 350, New York, 1920.

ASIA

British India

The highly aluminous character of some of the laterite deposits of India was noted some years ago. As a result of field work by the Geological Survey the existence of extensive deposits of bauxite in many parts of India has been established. Chemical analyses have shown that certain of the Indian bauxites compare favorably with some of the best bauxites of commerce except for their high content of titanium dioxide.

The principal deposits of high-grade bauxite are on the Baihir Plateau in the Balaghat district, and near Katni in the Jubbulpore district, both in the Central Provinces. Bauxite has also been found on the laterite plateaux in the western parts of Chota Nagpur and in Sarguja, and Orissa; in Bhopal and Rewah States, Central India; in the Satara district, Bombay; and in various parts of the Madras Presidency. The deposits of Balaghat and Jubbulpore have received most attention up to the present time. "Eight analyses of specimens and samples of the Balaghat bauxites have given results ranging between the following limits:[48]

Alumina	51.62 to 58.83
Silica	0.05 to 2.65
Ferric oxide	2.70 to 10.58
Titanium dioxide	6.22 to 13.76
Combined water	22.76 to 30.72
Moisture	0.40 to 1.14

Two Katni bauxites gave the following results:

	No. 1	No. 2
Alumina	65.48	52.67
Silica	0.38	1.26
Ferric oxide	3.77	7.04
Titanium dioxide	11.61	7.51
Water	19.38	29.83

"In western Chota Nagpur the rock laterite is believed to have been formed chiefly by hydration of basaltic lava flows.

"Several concessions have been taken out for working bauxite, especially in the Central Provinces, and as a result of the attention recently paid to them, and of schemes for the local production of aluminum and alumina, the Geological Survey of India has decided to examine all the known bauxite deposits in the Indian Empire and to publish a me-

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[48] Aluminum and bauxite, the Mineral industry of the British Empire and Foreign Countries, War Period (1913-1919), Imp. Min. Res. Bureau, pp. 15, 16, London, 1921.

moir on the subject. It was anticipated that the greater part of the field-work would be completed by the end of the season 1919-1920."[49]

Some bauxite has been produced in India since 1908. The yearly production is given in the table of world's production on p. 46.

China

"There is a persistent rumor, without confirmation, that bauxite has been discovered recently in China. As to this deposit no information is available."[50]

AFRICA

There are many notes scattered throughout geologic literature concerning laterites, some of which are highly aluminous, in most of equatorial Africa. Laterites are reported in such widely separated localities as Ashanti, Gold Coast, Rhodesia, Nigeria, Kongo, and French Guinea.

Gold Coast

A large deposit of high-grade bauxite was found recently by the Gold Coast Geological Survey.[51] It is at and near the summit of Mt. Ejuanema on the Kwahu Plateau, two miles to the west-south-west of Mpraeso and about a mile to the south-south-west of Obomen. The summit of the hill is 2,300 feet above sea level and approximately 1,000 feet above the Asuboni River. The beds, which consist of a series of irregularly alternating sandstones, sandy shales, and clay shales, are nearly horizontal, but in some cases have slight inclinations to the north or northwest.

"Bauxite is seen in situ along the whole of the rim of the top of the mountain and at the summit over a large area, also at various places below the broken rim for 100 feet below the summit.

"Samples taken were passed through a 40-mesh sieve, the coarse and fine portions being analyzed separately. The coarse portion constituted 95 per cent of the whole and consisted of granular bauxite, while much of the fine material was of the same granular character. The average of sev-

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[49] *Op. cit.*

[50] Hill, James M., Bauxite and aluminum, Political and commercial geology and the World's mineral resources, J. E. Spurr, Editor, p. 351, New York, 1920.

[51] Aluminum and bauxite, the Mineral industry of the British Empire and Foreign Countries, War Period (1913-1919), Imp. Min. Res. Bureau, pp. 9, 10, London, 1921.

enteen analyses of the coarse portion was as follows:

Alumina	60.55
Ferric oxide	9.75
Titanium oxide	2.21
Silica	1.42
Lime and magnesia	0.73
Moisture	25.59

"At the present time the nearest railway station is Tafo, 40 miles to the south. Coomassie railway station is 65 miles to the west. The railway from Tafo to Coomassie is now being extended, and will pass within a mile of the foot of Mt. Ejuanema and within two miles of the deposit. An aerial ropeway will be necessary to connect the mine with the valley below.

"The total amount of bauxite available at Mt. Ejuanema is estimated to be about 3,000,000 tons."

Togoland and French Guinea

Bauxite deposits are known at Dalawe in Togoland.[52] In French Guinea small deposits of bauxite have resulted from the alteration of gneisses and feldspathic igneous rocks, according to Hill.[53] These deposits are reported to be under development.

Bauxite has been reported from the former German colony of Kamerun. Bauxite deposits have been reported also from the Union of South Africa.

AUSTRALIA

There are numerous references in the government reports and in the technical journals concerning the laterites and bauxitic laterite of Australia. Deposits of bauxitic laterite and bauxitic clay have been found in Queensland, New South Wales, South Australia, and Western Australia.

New South Wales

Probably the largest and best-known deposits are in New South Wales at Emmaville and Inverell in the northern part of the state and at Wingello in Camden County. All the deposits are low in aluminum oxide and high in ferric oxide; and some of them are high in silica.

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[52] Hill, James M., Bauxite and aluminum in 1919, U. S. Geol. Survey, Mineral Resources, 1919, Pt. 1, p. 37, 1920.

[53] Hill, James M., Bauxite and Aluminum in 1918, U. S. Geol. Survey, Mineral Resources, 1918, Pt. 1, p. 522, 1920.

There are three deposits in the vicinity of the village of Wingello, a railway-station on the main southern line, 110 miles from Sydney. The deposits are 1 to 5 miles south of Wingello. In May, 1899, J. B. Jaquet, reporting the presence of a deposit of pisolitic ironstone near Wingello, stated that the ore contained free alumina and was a variety of bauxite.[54] In his memoir on the Iron ore deposits of New South Wales in 1901, the same author described the two principal areas. The third deposit is some two miles south of the area covered by his report. According to the report "the bauxite ores occur in beds from ten to twenty feet(?) thick, generally upon the summit of low, isolated, flat-topped hills, which resemble miniature tablelands, and are often thickly timbered. The sides of these hills are, invariably, either strewn with debris derived from above or are deeply covered with a bright red soil, so in the absence of shafts and trenches it is impossible to accurately determine the true thickness of the beds. With one exception, all the deposits which we examined were situated upon the top of the Tertiary beds; we never found any of them interstratified with other rocks, nor overlain with basalt. The exception is Deposit 33, which apparently rests directly upon the Hawkesbury sandstones, though we have no certain proof that such is the case.

"The ore is composed of a number of rounded grains, embedded in an earthy ground-mass, which includes numerous glistening sand-grains, and varies in color from pale-yellow to chocolate-brown, the depth of color being dependent upon the quantity of iron which is present."[55]

A comparison of the analyses of the deposits at Wingello shows the similarity of these ores to the so-called "bole with some pisolitic ore", found in the deposits at Glenariff, Ireland. The Irish ores are used largely in fluxing iron ore.

According to Harper, "Several shallow shafts have been sunk along the crest of the deposit known as No. 26, but bed-rock has not been reached in any of them. The ore shows solid in the shafts, and is very hard and uniform in character.

"Average samples of the ore exposed were obtained, together with samples from the other two deposits visited,

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[54] Ann. Rept. Dept. Mines and Arig. N. S. Wales for 1899, p. 176, Sydney.

[55] Jaquet, J. B., The Iron ore deposits of New South Wales: Memoirs, Geol. Survey, N. S. Wales, Geology, No. 2, p. 96, Sydney, 1901.

and analysed in the departmental laboratory with the following results:

Locality—	*Free Alumina*	*Ferric Oxide*	*Silica*	*Water*	*Assay No.*
1. Portion 58, parish of Bumballa, county of Camden, 5 miles south of Wingello. Shaft 8 feet deep	23.90	26.60	12.92	20.54	276/21
2. Portion 36, parish of Bumballa, county of Camden, 3 miles south of Wingello. Hole 3 feet deep	28.80	26.60	9.48	21.74	277/21
3. Portion 151, parish of Wingello, county of Camden, 1 mile south of Wingello. Shaft 13 feet deep	34.62	25.80	13.56	20.94	278/21
4. Ditto	36.66	34.06	5.32	21.20	279/21
5. Portion 151, parish of Wingello, county of Camden, 3 miles south of Wingello. Shaft 15 feet deep	34.26	36.40	4.80	21.42	280/21
6. Portion 151, parish of Wingello, county of Camden, 3 miles south of Wingello. Shaft 11 feet deep	36.16	33.80	1.76	21.18	281/21

"Efforts to economically test this class of ore for its aluminum contents have so far not met with success either in India or Ireland, but it may be found that the Wingello ore can be so treated on a commercial scale, and, as the tonnage is large, it is certainly worthy of attention."[56]

"The extensive deposits in the Moss Vale Division close to Wingello railway station have attracted attention. Areas have been taken up by N. G. Roper, and the erection of a large and expensive plant for the recovery of the aluminum from this ore is contemplated. Prospecting has also disclosed important deposits about 2 miles south-easterly from the above areas. C. de Wett has been testing deposits in the Inverell Division with a view to their development on a commercial basis."[57]

The deposits at Wingello have been estimated by Jaquet to contain very large quantities of ore. However, very little is known regarding the thickness of the ore beds in these deposits. In each case an assumed thickness of the bauxite has been used in making estimates.

The deposits in the Emmaville and Inverell districts have not been systematically examined and sampled to determine whether or not they contain ores of higher grade.

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[56] Harper, L. F., Aluminous iron ores, Wingello: Ann. Rept. Dept. Mines, N. S. Wales, 1921, p. 58, Sydney, 1922.

[57] Ann. Rept. Dept., Mines, N. S. Wales, 1921, p. 36, Sydney, 1922.

The following analyses show the quality of the ore:[58]

Analyses of bauxite ores from the Inverell and Emmaville districts made in the Laboratory of the Department of Mines during 1899.[58]

Registered number—	1347	1346	4774	4775	4776	4777	1381	1382	1383	3571	3572	3573	1508
Moisture at 100° C.	1.83	1.95	-----	-----	-----	-----	2.66	2.40	2.42	-----	-----	-----	-----
Combined water	17.40	21.50	-----	-----	-----	-----	23.68	22.39	17.96	-----	-----	-----	-----
Silica (SiO_2)	16.40	.16	3.00	5.10	3.80	20.20	4.10	1.70	15.01	3.40	3.00	4.30	4.
Ferric oxide (Fe_2O_3)	13.59	28.91	19.15	26.87	39.30	26.99	24.18	28.65	27.06	35.98	27.41	29.65	59.
Ferrous oxide (FeO)	trace	trace	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Alumina (Al_2O_3)	47.84	42.20	46.95	41.43	35.00	33.21	41.68	38.97	31.43	35.62	38.79	39.95	20.
Manganous oxide (MnO)	trace	trace	-----	-----	-----	-----	trace	trace	trace	-----	-----	-----	-----
Lime (CaO)	.74	.28	-----	-----	-----	-----	.80	.50	absent	-----	-----	-----	-----
Magnesia (MgO)	.23	.37	-----	-----	-----	-----	.14	.18	.40	-----	-----	-----	-----
Potash (K_2O)	.20	.17											
Soda (Na_2O)			-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Titanic acid (TiO_2)	1.77	4.75	-----	-----	-----	-----	2.05	4.35	4.98	-----	-----	-----	-----
Phosphoric acid (P_2O_5)	.14	.26	-----	-----	-----	-----	.23	.37	.34	-----	-----	-----	-----
Sulphur trioxide (SO_3)	absent	absent	-----	-----	-----	-----	absent	absent	trace	-----	-----	-----	-----
Vanadium oxide (V_2O_5)	traces	absent	-----	-----	-----	-----	trace	.06	strong trace	-----	-----	-----	-----
Loss on ignition	-----	-----	27.50	23.95	19.25	18.00	-----	-----	-----	23.63	25.69	22.92	-----
Copper oxide (CuO)	-----	-----	-----	-----	-----	-----	-----	-----	minute trace	-----	-----	-----	-----
Iron (Fe)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
	100.14	100.55	-----	-----	-----	-----	99.52	99.57	99.60	-----	-----	-----	-----

1347—Emmaville
1346—Emmaville
4774—Ph. Wandera, Emmaville
4775—Ph. Wandera, Emmaville
4776—Ph. Wandera, Emmaville
4777—Ph. Wandera, Emmaville
1381—Warialda Road 9½ miles from Inverell
1382—From 5 mile peg on Warialda Road, Inverell
1383—Byron Paddock, about 5 miles from Inverell North
3571—North of Inverell
3572—North of Inverell
3573—North of Inverell
1508—Inverell

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[58] Jaquet, J. B., The Iron ore deposits of New South Wales: Memoirs, Geol. Survey N. S. Wales, Geology, No. 2, p. 104, Sydney, 1901.

Jaquet says, "there are extensive deposits of ferruginous ore on portion 40, Parish of Bungonia, about six miles south of Bungonia township, and also near the adjoining Yarralaw Trigonometrical Station. The deposits contain many thousand tons of ore, which, though containing a high percentage of silica (sand) are admirably adapted for magnetic concentration."

"Upon Portions 135 and 154, Parish of Tarago, about six miles from Collector, we found a small deposit of the ore capping an outlier of Tertiary sandstone."[59]

At Bullahdelah in New South Wales deposits of alunite, consisting of 375 acres, are worked as a source of potash alum by the Australian Alum Company. The alunite is exported for treatment in England. Production has fallen off in recent years as the marketable material has become more difficult to locate. In 1918 it was 3,406 tons, in 1919 it was 2,485 tons, in 1920 it dropped to 634 tons, and in 1921 to 520 tons.[60]

Queensland

In Queensland[61] there are a number of deposits of bauxite including those at Cania about 60 miles southwest of Gladstone, at Crow's Nest near Toowoomba, and at Cooranga Station in the Gayndah district.

"Saint-Smith describes bauxitic laterite near Charters Towers, Queensland, as derived from the weathering of granodiorite and mentions one bed in particular that may be good bauxite."[62]

"Eighteen miles west of Springsure, near the Tambo road, there is a deposit of alunogen, a hydrated sulphate of alumina, covering the exposed faces of a low escarpment of sandstone, the rock itself being highly impregnated with the mineral wherever it has been tested."

References.

Saint-Smith, E. C., Laterite deposits near Charters Towers: Queensland Govt. Min. Jour., vol. 22, p. 359, 1921 (Ref. from Hill).

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[59] *Op. cit.*

[60] Alunite: Ann. Rept., Dept. Mines, New South Wales, 1921, p. 35, Sydney, 1922.

[61] Aluminum and Bauxite, the mineral industry of the British Empire and Foreign Countries, War Period (1913-1919): Imp. Min. Res. Bureau, p. 18, London, 1921.

[62] Hill, James M., Bauxite and Aluminum in 1921: U. S. Geol. Survey, Mineral Resources, 1921, p. 67, August 1, 1922.

South Australia

"In South Australia a bauxitic clay, which is considered of commercial value, has been found in the Yanhabilla district."[63]

Western Australia

The residual deposits of laterite cover extensive areas in Western Australia. As a result of the ease with which they could be smelted rather than on account of their richness or purity, some of these laterites have been used in the past as a source of iron ore for fluxing purposes. Some of them have a fairly high content of alumina.

The most extensive deposits of aluminous laterite or bauxitic clay are those which cap the Darling Range, north of Perth; other deposits are in the Wongan Hills, 132 miles from Perth on the Perth-Mullewa railway line, and at Greenbushes, 159 miles from the metropolis on the Perth to Bridgetown railway line.

"The laterite at Smith's Mill, which analyses show to contain from 13.98 to 50.68 per cent of alumina, were examined and reported on in 1902, whilst in 1912 a further investigation was made of the deposits, and samples when analysed were found to contain in parts per hundred:

	a	*b*	*c*
Bauxite	9.53	35.10	55.87
Kaolin	17.55	26.64	23.70

"The Smith's Mill bauxite does not attain very great thickness, and is seen to pass by almost imperceptible gradations from an ironstained and white clay into the underlying granite and gneiss of which it is the decomposition product.

"This laterite extends eastward to Baker's Hill, 47 miles from Perth; it is, however, much more ferruginous than the Smith's Mill ore; that from Gooseberry Hill, on the Midland Junction to Karragullen railway line, distant about 19 miles from Perth and southwest from Smith's Mill, is also very ferruginous.

"A considerable number (46) of samples of bauxitic laterite from different portions of the Darling Range have been analysed in the Geological Survey Laboratory; under conditions at present prevailing it appears that the lowest grade of bauxite which may be regarded as payable is that which contains not less than 35 per cent of alumina soluble in acids.

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[63] Aluminum and Bauxite, The mineral industry of the British Empire and Foreign Countries, War Period (1913-1919): Imp. Min. Res. Bureau, p. 18, London, 1921.

"The analyses of the Darling Range laterite show that they can be grouped as follows:

Acid soluble,	Al_2O_3, under 35 per cent	20
" "	Al_2O_3, from 35-40 per cent	15
" "	Al_2O_3, from 40-45 per cent	6
" "	Al_2O_3, from 45-50 per cent	5
		46

"Those varieties of bauxitic laterite which contain the highest percentage of acid soluble alumina are composed of a light colored yellow matrix, through which nodules of brown iron hydrate, or decomposed quartz rock of about the size of peas, are scattered, and may be readily distinguished by the unaided eye.

"So far as observations have at present been carried it appears that in the Darling Range the laterites situated on the highest ground are richer in soluble alumina than those at the lower levels, hence it appears possible to distinguish at sight between bauxitic laterites of low and of high grade. According to the researches of Dr. Simpson in the Survey Laboratory, it appears that the higher grade bauxites weigh 157 lbs. to the cubic foot; so that assuming the average thickness of the bauxitic laterites to be two feet, each acre of ground should yield at least 6,000 tons of aluminum ore.

"Having regard to the known extent of the deposit it appears that there are hundreds of thousands of tons of high grade laterite within easy access of those railway lines which cross the Darling Range."[64]

Partial analyses of the laterites of the Darling Range are given in the following tables:[65]

Smith's Mill—				
Alumina, Al_2O_3*	35.22	28.56	39.56	27.42
Ferric oxide, Fe_2O_3	32.96	37.94	30.14	45.14
Insoluble	----	----	----	----
Mahogany Creek—				
Alumina, Al_2O_3*	30.62	30.48	42.88	29.94
Ferric oxide, Fe_2O_3	36.72	27.84	22.96	16.98
Insoluble	----	----	15.44	----

*Includes TiO_2

	Guppy Siding		*Sawyers' Valley*			*Bickley*
Alumina, Al_2O_3*	43.52	40.06	47.91	37.96	37.11	37.58
Ferric oxide, Fe_2O_3	29.52	30.14	9.79	29.68	26.01	21.12
Insoluble	3.96	8.24	16.89	18.59	19.98	19.50

*Includes TiO_2

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[64] Maitland, A. Gibb, The bauxite deposits (Aluminuous laterite) of Western Australia: Extract from the Mining Handbook, Geol. Survey Memoir No. 1, pp. 3-5, Perth, 1919.

Analyses of laterites from the Darling Range between Kalamunda and Walliston Stations:

	B1	B2	B3	B4	B5	B6	C1	C2
Soluble in acids								
Al_2O_3	35.44	32.20	39.77	31.23	25.43	36.59	34.59	30.75
Fe_2O_3	25.26	36.44	23.66	35.59	44.09	27.13	29.70	21.00
TiO_2	.90	.94	1.01	.96	1.80	1.56	1.41	1.27
Insoluble in acids								
SiO_2	17.22	-----	11.48	-----	-----	-----	-----	-----
Al_2O_3, etc.	1.70	14.82	1.54	12.50	11.38	12.02	12.26	29.56
Ignition loss								
Combined water Hygroscopic water	19.34	15.60	22.78	20.00	17.30	29.26	22.04	16.73 .85
	99.86	100.00	100.24	100.28	100.00	100.26	100.00	100.16

Analyst E. S. Simpson B1—B6, H. Bowley C1, D. G. Murray C2.

Analyses of the samples of bauxite from the Minhadine Range[66] (South of the railway line between Tammin and Kellerberron):

	3685	3686	3687	3688
Insoluble in acids	52.44	57.88	60.96	57.18
Titanium dioxide, TiO_2	.58	.66	.70	.62
Ferric oxide, Fe_2O_3	9.16	7.48	4.94	9.02
Alumina, Al_2O_3	26.10	23.74	22.92	22.98
Water (combined)	10.78	9.63	9.37	9.84
Water (hygroscopic)	1.18	1.04	.93	.78
	100.24	100.43	99.82	100.42

Alumina and Silica soluble in 10 per cent Sodium hydrate after heating on a water bath for one hour:

	Alumina, Al_2O_3	Silica, SiO_2
3685	10.18 per cent	9.26 per cent
3687	11.16 per cent	9.70 per cent

"An extensive deposit of fairly high grade laterite (44.66 per cent of alumina), of which a complete analysis will be found in the table below, occurs in the Wongan Hills, 132 miles from the metropolis, on the Perth-Mullewa railway line, and distant about six miles west from it.

"The Wongan Hills laterite does not form a horizontal tableland, but is a residual deposit which has adapted itself

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[65] *Op. cit.*
[66] *Op. cit.*

to the original form of the ground on which it occurs. Outliers of the laterite occur in several localities, and it is quite evident that it originally spread over a wide area and that extensive denudation has taken place since the deposit constituted one continuous formation. The rock is very porous and weathers readily into caverns and cavities of all sizes, and when freshly broken it presents a mottled appearance owing to the different shades of brown, yellow, and red. Lithologically, the deposits present all gradations from ferruginous claystone to pure limonite, the former, however, predominating. As the laterite is seen to pass by insensible gradations into the underlying rocks without any sharp line of demarcation, its formation would seem to have been due to the alteration in situ of the rocks beneath."[67]

G. S. M. No. 997 N Rock Laterite. Locality: Wongan Hills.

SiO_2	5.96	H_2O+	26.44
Al_2O_3	44.66	TiO_2	3.10
Fe_2O_3	19.08	SO_3	.18
MnO_2	----	P_2O_5	Trace
MgO	Trace	Cr_2O_3	----
CaO	Trace	V_2O_5	----
H_2O-	.58		
			100.00

Analyst E. S. S. 1901

"At Greenbushes, on the Perth to Bridgetown railway line, and distant 159 miles from the metropolis, there is a very large area of laterite nowhere exceeding 20 feet in thickness, some portions of which appear to be of high grade. Partial analyses of the bauxitic laterites from Greenbushes and Donnybrook are given in the table:

Partial analyses of bauxitic laterites from Greenbushes and Donnybrook:

Greenbushes—						
Alumina, Al_2O_3*	28.70	33.24	33.10	26.28	25.62	27.00
Ferric oxide, Fe_2O_3	35.50	34.12	18.82	19.44	32.90	23.56
Insoluble	20.44	17.68	30.40	40.44	32.04	35.16
Donnybrook—						
Alumina, Al_2O_3*						29.98
Ferric oxide, Fe_2O_3						12.54
Insoluble						40.12

*Includes TiO_2

"The most important constituent of these laterites is, next to ferric oxide, gibbsite (Al_2O_3,$2H_2O$). The latter contains iron sesquioxide as an impurity in variable amounts, sometimes exceeding that of the alumina, and affords a

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[67] *Op. cit.*

ready basis of classification into (a) the light colored or non-ferruginous, and (b) the red colored or ferruginous varieties."

"Aluminum being producable from bauxite by means of the electric furnace, it naturally suggests itself as to whether the reserve of energy in the coals of the Collie Field could not be utilized for the production of the electric power necessary for this and any other allied purpose."[68]

References.

Maitland, A. Gibb, The bauxite deposits (Aluminous Laterite) of Western Australia: Extract from the Mining Handbook, Geol. Survey Memoir No. 1, Perth, 1919.

Bulletin 67—Analyses of Western Australian Rocks, Meteorites, and Natural Waters, Geol. Survey.

World's Production of Bauxite in Long Tons, 1900-1922

	United States	France	United Kingdom	Italy	India	British Guiana	Spain
1900	23,184	*a*58,530	*a*5,873	------	------	------	------
1901	18,905	*a*76,620	*a*10,357	------	------	------	------
1902	27,322	*a*96,900	*a*9,192	------	------	------	------
1903	48,087	131,781	6,128	------	------	------	------
1904	47,661	74,449	8,700	------	------	------	------
1905	48,129	101,378	7,300	------	------	------	------
1906	75,332	115,926	6,654	------	------	------	------
1907	97,776	155,834	7,537	3,445	------	------	------
1908	52,167	167,991	11,716	6,890	32	------	------
1909	129,101	128,099	9,500	3,881	32	------	------
1910	148,932	192,913	3,792	4,524	66	------	------
1911	155,618	250,818	6,007	5,600	12	------	------
1912	159,865	254,851	5,790	6,596	950	------	------
1913	210,241	304,323	6,055	6,840	1,184	------	------
1914	219,318	*b*	8,286	3,844	*e*514	------	------
1915	297,041	55,614	11,723	5,805	876	------	------
1916	425,100	104,493	10,329	8,744	750	------	------
1917	568,690	118,973	14,724	7,664	1,363	2,037	------
1918	605,721	*b*	9,589	7,675	1,192	4,199	453
1919	376,566	160,820	9,221	2,924	1,682	*a*2,008	1,751
1920	521,308	*d*186,693	*a*11,197	*c*13,139	*b*	*a*31,883	------
1921	139,550	*d*84,942	*b*	*c*49,100	*b*	------	------

*a*Metric tons
*b*Statistics not available
*c*Istria included under Italy—metric tons
*d*Unofficial—metric tons
*e*Used only in the manufacture of cement

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[68] *Op. cit.*

Estimated World's Production of Aluminum, Long Tons[a]

	1913	1914	1915	1916	1917	1918	1919
United Kingdom	7,500	7,400	7,000	7,600	7,000	8,200	8,000
Canada	6,000	6,500	6,000	7,500	8,000	8,000	8,000
Austria	2,000	2,000	----	----	----	----	----
France*	13,283	9,803	5,920	9,447	10,886	11,826	12,000
Germany	1,000	1,000	1,000	8,000	20,000	25,000	12,000
Italy*	860	922	889	1,108	1,712	1,687	2,000
Norway	2,000	4,000	8,000	12,000	15,000	15,000	10,000
Switzerland	10,000	15,000	10,000	12,500	15,000	15,000	15,000
United States	29,000	41,500	44,500	62,500	80,000	85,000	80,000
	71,643	88,125	83,309	120,655	157,598	169,713	147,000

*Official figures. 1919 figures estimated.

[a] Aluminum and bauxite (1913-1919), the mineral industry of the British Empire, War Period: Imp. Min. Res. Bureau, p. 7, London, 1921.

THE BAUXITE DEPOSITS OF THE UNITED STATES

(Exclusive of Mississippi)

Location

The bauxite deposits of the United States exclusive of Mississippi are in Arkansas near Little Rock; in central Georgia; in the adjacent parts of Georgia, Alabama, and Tennessee; and in northeast Tennessee. There are deposits of diaspore in central Missouri. Some deposits of bauxitic clay have been found recently in Colbert County in northwest Alabama. A deposit of bauxitic laterite and bauxite has been reported from Riverside County, California.

Arkansas

Introduction

Arkansas contains the most important bauxite deposits in the United States. Since 1910 this state has produced more than 80 per cent of the bauxite mined in this country. Nearly all of it is used in the manufacture of the metal, aluminum. It is of Tertiary age, residual, and was derived by weathering from nepheline syenite.

Discovery

The bauxite deposits of Pulaski County were discovered by J. C. Branner in June, 1887, but no announcement was made until January, 1891. The deposits, or at least some of them, seem to have been described as an "amygdaloid formation" in 1842 by Dr. W. Byrd Powell. Owen also mentioned a "ferruginous amygdaloid of rather a peculiar character".

Branner's Description

They have been described by Branner,[69] Williams,[70] Hayes,[71] and Mead.[72] In his report of 1891 Dr. John C. Branner, State Geologist of Arkansas, said in part:

"The Arkansas beds occur near the railway in the vicinity of Little Rock, Pulaski County, and near Benton, Saline County. The exposures vary in size from an acre to twenty acres or more, and aggregate over a square mile. This does not in all probability include the total area covered by bauxite in the counties mentioned, for the method of occurrence of the deposits leads to the supposition that there are others as yet undiscovered by the Survey. In thickness the beds vary from a few feet to over 40 feet, with the total thickness undetermined; the average thickness is at least 15 feet.

"These Arkansas deposits occur only in Tertiary areas and in the neighborhood of eruptive syenites ('granites'), to which they seem to be genetically related. In elevation they occur only at and below 300 feet above tide level, and most of them lie between 260 and 270 feet above tide. They have soft Tertiary beds both above and below them at a few places, and must therefore be of Tertiary age. As a rule, however, they have no covering, the overlying beds having been removed by erosion, and are high enough above the drainage of the country to be readily quarried. Erosive action has removed a part of the bauxite in some cases, but there are in all probability many places at which it has not yet been even uncovered. It is pisolitic in structure, and, like all bauxite, varies more or less in color and in chemical composition. At a few places it is so charged with iron, that attempts have been made to mine it for iron ore. Some of the samples from these pits assay over 50 per cent of metallic iron. This ferruginous kind is exceptional, however. From the dark-red varieties it grades through the browns and yellow to pearl-gray, cream-colored, and milky-

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[69] Branner, John C., Bauxite in Arkansas, American Geologist, March, 1891, vol. 12, pp. 181-183. The Bauxite Deposits of Arkansas, Jour. Geol., vol. 5, pp. 263-289, 1897.

[70] Williams, J. Francis, Igneous Rocks of Arkansas, Ann. Rept. Geol. Survey Arkansas, 1890, vol. 2, pp. 22, 29-31, 124-125, and 162.

[71] Hayes, C. W. The Arkansas Bauxite Deposits, Twenty-first Ann. Rept., U. S. Geol. Survey, Part 3, pp. 435-472.

[72] Mead, W. J. Occurrence and Origin of the Bauxite Deposits of Arkansas, Econ. Geology, vol. 10, pp. 28-54, 1915.

white, the pinks, browns and grays being the more abundant. Some of the white varieties have the chemical composition of kaolin, while the red, brown, and gray have but little silica and iron, and a high percentage of alumina."[73]

Production and Reserves

Since 1910 Arkansas has produced more than 80 per cent of the bauxite mined in the United States; in 1915, 1918, and 1920 it produced more than 90 per cent. The reasons for this prominence are (1) the American Bauxite Company, the principal producer of bauxite in America, has concentrated its mining operations in Arkansas; and (2) the Arkansas ore is best suited to the manufacture of the metal. The production, however, bears no relation to the state's rank in reserve deposits. In fact the great interest shown in the bauxite deposits of British Guiana by the Aluminum Company of America may be due to the decrease in the Arkansas reserves resulting from the enormous production from that state. In 1900, Hayes estimated the bauxite in outcrops to be 6,601,500 long tons and under cover to be 43,711,200 long tons. At that time the deposits had been barely opened, and very little bauxite had been shipped. After 14 years of development of the deposits and after 8 months of field work in 1912 and 1913, including the detailed mapping of 18,000 acres of land, for the most part in the productive portions of the district; the sinking of 1,152 test pits and 52 drill holes, aggregating 35,000 vertical feet, of which over one-third was in bauxite and associated kaolinized syenite; and the analyzing of about 2,400 samples, Mead decides "that Dr. Hayes' estimates of tonnage are very greatly in excess of the amount of bauxite actually present."[74]

Location of Deposits, and Methods of Working

The principal production is from an area of about 12 square miles known as the Bauxite District, also as the Bryant District, lying about 18 miles southwest of the city of Little Rock in Bryant Township, Saline County. Bauxite, the town from which the ore is shipped, is on the Chicago, Rock Island, and Pacific Railway, 5 miles east of Benton, the county seat of Saline County. The mines are on the Bauxite and Northern Railway, a spur built from Bauxite Junction on the St. Louis, Iron Mountain, and Southern Railway System. This spur crosses the Rock Island tracks at Bauxite Station. The second and less important district, embracing

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[73] *Op. cit.*
[74] *Op. cit.*

an area somewhat larger than the Bauxite District, is the Fourche Mountain District, lying immediately south of the city limits of Little Rock in Pulaski County. The two areas are about 14 miles apart.

All the bauxite is mined from open pits. The overburden, which reaches a maximum of 40 feet at some places, is usually removed by steam shovels. The uneven nature of the beds of bauxite and the close grading required make it necessary to mine part of the ore by hand.

Classes and Geological Relations of Ore

Mead divides the bauxite deposits into two main classes: (a) bauxite in place, and (b) transported and detrital bauxite. He believes that the bauxite in place is a residual product of the surface weathering of the syenite. This bauxite grades downward into kaolin, which in turn grades into syenite. The deposits are horizontal, tabular beds of very irregular outline and yield most of the ore. The transported bauxite is interstratified with Tertiary sediments. The original bauxite beds suffered considerable erosion during Tertiary time, and in a few cases, the material removed has been redeposited in lenses of comparative purity. The bauxite in place suffered also from erosion and at some places grades upward into a Tertiary basal conglomerate, which is composed largely of bauxite boulders. The quantity of sand in the detrital layer may be great enough to render part of the ore nonmerchantable.

Quoting from Mead, "Owing to the erosion which the bauxite beds suffered during Tertiary and recent times, the portions remaining have very irregular outlines and vary greatly in size. The deposits are bounded either by wedging out against a rise in the underlying syenite or by an erosional valley. The thickness of the bauxite on the whole is comparatively uniform. The maximum known thickness of bauxite is 35 feet, but depths such as this are very exceptional and local. The average thickness of merchantable ore is about 11.5 feet. The surface under the bauxite, exposed after the bauxite has been removed, is extremely uneven and irregular. In places the underlying clay extends through the bauxite to the surface, and throughout the bauxite beds horses and stringers of clay are so abundant that in the average case 40 per cent of the material handled in mining must be discarded as waste. This figure is greatly exceeded in some places. The clay horses are everywhere abundant—they occur in every variety of shape and size, and add greatly to the cost of mining."[75]

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[75] *Op. cit.*

The following section shows the relation of the beds in the Radcliffe mines of the Republic Mining and Manufacturing Company, 5 miles southeast of Little Rock:

Section of Radcliffe mine, southeast of Little Rock, Arkansas—[76]

	Feet
Overburden	3
Bauxite, maximum	12
Gray clay	Variable

Physical Characteristics of the Ore

The ore varies greatly in texture and color. The prevailing color is a light buff, which grades into white and various shades of yellow, brown, and red. Some of the ore has been stained dark by organic material, and some of the gray ore owes its color in part to the presence of iron carbonate. The red color is not always a safe criterion in estimating the amount of iron, as it may be only a stain, and some of the gray ores may be high in iron carbonate.

According to Mead, the bauxite varies in hardness from that of a limestone or well-cemented sandstone to a soft material which can be shoveled without picking. The hard beds of ore cap the deposits and the soft portions are found below. All of the ore requires more or less blasting before it can be loaded.

"The bauxite has a comparatively high porosity, an average of a number of tests showing 38.5 per cent pore space. The free moisture in the ore varies greatly with the season of the year, the ore being practically saturated during the wet season, while the upper portions of some of the more exposed deposits above the water level are well dried out during the summer months. The moisture content (uncombined water) of the ore mined varies from 5 per cent to a maximum of 20 per cent, with an average between 12 and 15 per cent. As the ore is dried before shipment and sold on the basis of dry ore, the moisture content is not as important as in the case of ore sold on the basis of natural, or 'green' ore. On the average it requires 24 cubic feet of green ore in the ground to produce one long ton (2,240 pounds) of dried ore.

"The ore exhibits a variety of textures. The most common type is a pisolitic or 'oolitic' ore, made up of more or less spherical pisolites of bauxite, sometimes having concentric structure in a bauxite matrix. These vary in size from microscopic to a maximum of an inch or more in diameter.

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[76] Ries, H., and Bayley, W. S., and others, High-grade Clays of the Eastern United States, U. S. Geol. Survey, Bull. 708, p. 120, 1922.

Occasionally on an erosion surface of ore, the pisolites are weathered out, yielding a gravel ore. Second in importance is the ore having the texture of syenite, commonly called 'sponge ore' or 'granitic ore'. This bauxite preserves in varying degrees the original granitic texture of the syenite. This texture is so perfectly preserved in some instances that it is only possible to distinguish an outcrop of granitic bauxite from a weather-stained outcrop of syenite by breaking into it with a hammer.

"The granitic type of ore is generally found beneath the oolitic ore and grading upward into it. Granitic bauxite grades downward into kaolinized syenite, and this in turn into unaltered syenite. The granitic type of bauxite is confined to the bauxite in place except for small rounded boulders found occasionally in the detrital upper portion of the deposits.

"The third type of ore is the amorphous ore which has the texture and appearance of clay, from which it is distinguished with difficulty. In many cases a chemical analysis is necessary to distinguish a merchantable ore from kaolin. This is the least abundant of the types mentioned.

"There is a complete gradation between the various types of ore. The pisolitic ore is found mixed in all proportions with the amorphous ore. One finds ore consisting largely of a 'clay' bauxite with a few small pisolites grading into a bauxite made up entirely of pisolites. The pisolitic structure is distinctly more pronounced in the upper portions of the ore bodies, and the granitic type is more characteristic of the lower portions. All of the types of bauxite grade into kaolin by very gradual changes so that it is difficult at all times to tell just which material to mine and which to reject.

"In many of the deposits disturbance by Tertiary streams has given rise to a detrital or conglomeratic ore in the upper portion. This consists of boulders of oolitic or granitic bauxite in a matrix of smaller boulders and finer bauxite material. This may either be of merchantable grade or mixed with Tertiary sediments to such an extent as to render it valueless."[77]

Chemical and Mineralogical Composition

In all the deposits there is a complete gradation from the composition of gibbsite ($Al_2O_3.3H_2O$) to the composition of kaolin ($Al_2O_3.2SiO_2.2H_2O$). In places there is a complete gradation from bauxite to practically pure iron carbonate.

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[77] Mead, W. J., Occurrence and origin of the bauxite deposits of Arkansas, Econ. Geology, vol. 10, pp. 37, 39, 40, 1915.

The iron carbonate found throughout the deposits of ore is of secondary origin; and in places it has replaced the bauxite, forming small pockets of nearly pure siderite. The ferric iron is present as the hydrated oxide and is derived from the original iron of the syenite and the oxidation of the iron carbonate. The titanium dioxide was present in the syenite and has been concentrated at places in the detrital beds of ore. The bauxite in place has a fairly uniform content of titanium dioxide, averaging about 2.5 per cent. In addition there are minute amounts of zirconia, barium, iron sulphide, and other accessory mineral constituents.

According to Mead the bauxite ore is composed of crystalline gibbsite and amorphous gibbsite, both approximating the formula $Al_2O_3,3H_2O$. The two varieties of the trihydrate, however, cannot be mined separately.

Quoting from Mead, "Microscopic study of thin sections of the bauxite reveals the fact that the granitic type of ore is largely composed of the crystalline form of aluminum trihydrate. The pisolitic type of ore is made up largely of the amorphous form, but this type of ore also contains a considerable amount of the crystalline form in the shape of remnants of feldspars which have been completely altered to gibbsite. It would seem from this that the hydrous aluminum oxide develops first in the form of gibbsite and that when it undergoes change, as in the development of the pisolitic type of ore, it tends to take on the amorphous form."[78]

Origin of the Deposits

Mead reaches the following conclusions in regard to the origin of the deposits:

"A study of the general geology, chemistry, and mineralogy of the deposits has led to the following conclusions:

"1. The bauxite and associated clays are the products of surface weathering of the syenite by normal processes of rock decomposition, and are in no sense chemical sediments.

"Bauxite deposits occurring on the syenite surface have developed in situ from the syenite.

"The deposits developed in situ from the syenite show evidence of downward secondary concentration of alumina.

"Bauxite lenses occurring interstratified with the Tertiary sediments consist of material which has been removed from its place of origin by Tertiary streams.

"2. The texture of the kaolinized syenite has been essential to the alteration of the kaolin to bauxite.

"3. The oolitic or pisolitic texture of the bauxite has

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[78] *Op. cit.*

developed in place from the granitic or amorphous types of bauxite."[79]

The bauxite beds have a vertical range of more than 200 feet in the Bauxite District alone.

The following table from Mead[80] shows the gradation from syenite to kaolin. All of the samples are from the same locality; No. 1 is fresh syenite from the cut near the Lantz Mine, No. 2 is partially kaolinized syenite, No. 3 is completely kaolinized syenite containing some bauxite, and No. 4 is bauxite.

Analyses of a series of samples from the same locality showing gradation from unaltered syenite No. 1, to bauxite ore No. 4:

	No. 1	No. 2	No. 3	No. 4
SiO_2	58.00	52.64	39.80	10.64
Al_2O_3	27.10	29.56	37.74	57.48
Fe_2O_3	1.86	1.06	1.60	2.56
FeO_3	3.30	.80	.10	.20
MgO	.25	.00	.00	---
CaO	1.62	.00	.00	---
Na_2O	6.70	4.46	---	---
K_2O	.25	.44	---	---
TiO_2	.40	1.20	3.30	1.20
H_2O	1.22	9.00	17.00	28.36

Downward Secondary Enrichment of Alumina

"The top portion of the bauxite deposit is characteristically higher in silica than the bauxite below. In many instances it has been necessary to remove the upper 18 inches or 2 feet of high silica ore before mining, thus adding greatly to the mining cost. A typical instance is shown in the following table of analyses of a series of samples from a test pit in bauxite:[81]

Marked	SiO_2	Fe_2O_3	TiO_2	Loss on Ignition	Al_2O_3 by Diff.
3'- 5'	24.85	4.84	1.3	22.97	46.04
5'- 8'	13.54	3.14	1.5	27.52	54.30
7'- 9'	14.63	3.24	1.5	28.22	52.41
9'-11'	7.73	2.63	1.3	30.36	57.98
11'-13'	9.96	3.19	1.4	29.04	56.41
13'-15'	9.65	1.59	1.7	29.89	57.16
15'-17'	9.00	2.99	1.6	29.56	56.76
17'-19'	13.29	2.32	1.8	27.69	54.90
19'-21'	11.88	2.11	1.8	28.44	55.77
21'-23'	7.08	2.57	2.0	30.25	58.09
23'-25'	6.84	2.02	1.7	29.91	59.53
25'-27'	7.33	3.04	1.7	30.63	57.30
27'-29'	5.52	2.16	2.8	30.69	58.83
29'-31'	5.70	2.11	1.9	30.53	59.76

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[79] *Op. cit.*

[80] *Op. cit.*

[81] *Op. cit.*

The syenite first alters to kaolin, which on further action of the surface waters loses silica and changes to bauxite of the "granitic" type, in which the original texture of the syenite is preserved. The gradation from bauxite through kaolinized syenite is found not only downward to the syenite beneath, but laterally and upward to residual boulders of decomposed syenite within the bauxite deposit. These boulders range from a foot to twenty feet in diameter and are found in all stages of decomposition, some having cores of fresh syenite and others, which have been completely altered to bauxite, being represented only by boulder forms in the bauxite. The open texture of the kaolinized syenite is essential in the change from kaolin to bauxite. This porous or spongy texture of the kaolinized syenite results from the leaching of the mineral nepheline. Further action, similar to concretionary growth, results in the formation of the usual pisolitic variety of bauxite.

Recent Development

During 1914 three companies besides the American Bauxite Company operated in Arkansas. The National Bauxite Company leased a property 7 miles south of Little Rock on the Rock Island Railway and began work at the beginning of the year. This particular property had never been worked before. The Globe Bauxite Company worked at Chemical Spur, Saline County; and the Republic Mining and Manufacturing Company operated near Little Rock in Pulaski County. The 1914 output of the state was 169,871 long tons, which was an increase over that of 1913.

In 1915 bauxite was produced in Pulaski County by the National Bauxite Company and the Republic Mining and Manufacturing Company. In Saline County the American Bauxite Company and the Globe Bauxite Company were active.

In 1916 the American Bauxite Company built a loading station at Bauxippi, Arkansas, to transfer bauxite from cars to river boats for transshipment to its plant at East St. Louis.

The American Bauxite Company, Globe Bauxite Company, E. I. du Pont de Nemours Company, and the Republic Mining and Manufacturing Company mined bauxite from the deposits in Saline and Pulaski counties during 1917.

The American Bauxite Company, Globe Bauxite Company, E. I. du Pont de Nemours Company, Republic Mining and Manufacturing Company, and the Norton Company mined bauxite in Saline and Pulaski counties in 1918.

The American Bauxite Company, the Globe Bauxite Company, E. I. du Pont de Nemours Company, and the Republic Mining and Manufacturing Company mined bauxite from deposits in Saline and Pulaski counties in 1919. All the bauxite used in the United States in the manufacture of aluminum in 1919 (272,270 long tons) came from Arkansas deposits. They furnished 28,981 long tons to the chemical industry, 31,180 long tons to the abrasive industries, and 1,059 long tons to the makers of refractories.

The American Bauxite Company, operating in the vicinity of Bauxite, greatly expanded its operations in 1920. Large deposits of bauxite were opened for handling by steam shovel; and during 1920 the company had a dozen steam shovels at work, some stripping the overburden of sandy clay from the bauxite and others digging bauxite. The ore is hauled by locomotives to the drying plant at the town of Bauxite, where the various grades are either dried or calcined before shipment. Early in the year it was estimated that about 10 cars of dried or calcined bauxite were being shipped daily. The Republic Mining and Manufacturing Company has opened a new bauxite deposit near the Soldiers' Home a few miles east of Little Rock; and the E. I. du Pont de Nemours Company and the Globe Bauxite Company are still working their mines in the same district.

The E. I. du Pont de Nemours deposits near Little Rock were worked for a short time in 1921, but the mines of the Republic Mining and Manufacturing Company were closed. The American Bauxite Company greatly curtailed its operations at Bauxite, Saline County. The Globe Bauxite Company continued about its normal capacity.

Georgia

Location and Age

The noted deposits of bauxite in Georgia are those of the Coosa Valley in the northwest part of the state. These deposits extend as an irregular belt between Adairsville, Georgia and Rock Run, Alabama, a distance of approximately 120 miles. They are in the middle and south parts of the so-called Paleozoic area, in Bartow, Floyd, Walker, Chattooga, Gordon, and Polk counties.

The deposits of central Georgia are in Wilkinson, Meriwether, Baldwin, Twiggs, and Washington counties in Lower Cretaceous beds; and in Sumter, Macon, Randolph, Schley, Webster, and Stewart counties in Tertiary beds.

Paleozoic Area

Bartow and Floyd counties formerly contained most of the ore bodies in the Paleozoic area of northwest Georgia. The deposits were grouped into two fairly well defined districts, known as the Hermitage district and the Bobo or Rome district. The remaining counties included only one or two deposits each, widely separated, as a rule, from each other.

The Hermitage district was the most important one in the Paleozoic area for many years. It comprised an area of more than 50 square miles, lying between Rome, Kingston, and Adairsville, east of the Oostanuala River and north of the Etowah River, and the contiguous northeast part of Floyd and the northwest part of Bartow counties. The northwest limits of the district were along a line of contact between the Knox dolomite and the underlying Conasauga shales. The deposits were irregularly distributed over the district, but, in some areas, they were numerous and close together.

Much of the Hermitage district has been exhausted, various mines having been abandoned from time to time. About 1913 Holland, Holland Springs, Church, Holland Hill, Julia, Watters, Armstrong, Stockade, No. 103, No. 104, Pine Spring, Maddox, Holland House, Ward, and Hardee mines were exhausted. Most of the operations of this region were by the Republic Mining and Manufacturing Company. Nearly all of the ore mined in the district was dried at Hermitage and shipped from Shannon, on the Southern Railway. In 1921 the Republic Mining and Manufacturing Company worked at Halls Station in Bartow County and at Hermitage and Vans Valley in Floyd County. The Kalbfleisch Corporation also mined ore at Halls Station. The production in this region has fallen rapidly since 1914; and it appears that the high grade ore in easily accessible places is nearly exhausted, the central Georgia field having produced most of the bauxite mined since 1914.

The Bobo or Rome district includes a number of ore mines between the Southern and the Central of Georgia railroads, about eight miles south of Rome. Three distinct deposits of ore are found two miles south of the town of Cave Spring, not far from the Alabama State line. They form the most southwesterly deposits known in this part of the state.

The remaining deposits in the Paleozoic area are in Chattooga, Walker, and Gordon counties. The Chattooga County deposits are in the vicinity of Summerville and Trion Factory; the Walker County deposits are on the Chattanooga and Southern Railroad near Chelsea; and the Gordon County deposits are about one mile northeast of Calhoun.

The rocks associated with the bauxite deposits of northwest Georgia range from Cambrian to Silurian in age. They consist of slates, limestones, shales, sandstones, and conglomerates. The beds have all suffered considerable metamorphism, with resulting change in lithologic character and structure. No rocks of igneous origin have been found within the area. The bauxite appears to be confined to the Knox dolomite series of rocks, a magnesian limestone formation of Cambro-Silurian age.

The Knox dolomite is the most uniform and persistent formation in the region. It lies on the Conasauga shales and consists of 3,000 to 5,000 feet of massively bedded, partially crystalline, gray, magnesian limestone. One of the characteristics of this dolomite is the presence of chert and flint as nodules and layers. Where weathering takes place the chert nodules are freed and the dolomite proper forms a vari-colored clay as a surface material. The great thickness of this residual material leaves but few exposures of the dolomite except where streams have cut through into the underlying shales.

The rocks of the region being sedimentary in origin, were originally laid down in a nearly horizontal position. Owing to subsequent folding, however, the beds now dip at steep and varying angles. In this section, as in the Appalachians in general, the folds are symmetrical. Like the normal Appalachian type, they have gentle dips on the southeast sides and steep ones on the northwest.

The continued action of the forces which produced the folding resulted in the fracturing and faulting of the beds in many places. Two classes of faults have been observed in the region, which show marked differences. These are designated by Hayes as minor thrust faults and major thrust faults. Apparently they bear no close relationship to each other and were probably formed at different periods of disturbance. The minor thrust faults seem to be the older. The two types of faults usually characterize separate or different parts of the region. The distribution of the bauxite seems to have a close relation with the faults.

In some localities in the Paleozoic area, the deposits of bauxite are in regularly stratified beds; in others, they are alteration or residual deposits. More commonly, however, they form well-defined pockets entirely separate from the enclosing residual material. Kaolin is invariably associated with the bauxite, and iron ore commonly.

In the pebble ore, the pebbles vary greatly in size, but the majority of them, perhaps, measure between three-quarters of an inch and one and one-half inches in diameter. They may be simple or complex in structure and well rounded to irregular in outline; and their nuclei are usually powdery and enclosed by hard concentric layers of varying thickness. In the pisolitic variety, the pisolites are between a quarter- and a half-inch in diameter and very hard; and both matrix and concretion break with a conchoidal fracture. The oolites, in the oolitic type, vary from the size of a pea down to the smallest ore grain. The concretions, where softer than the matrix, fall out on exposure, leaving a typical vesicular ore on the surface, which grades down into the concretionary varieties. The amorphous ore consists of a bauxitic clayey matrix, in which concretionary structure is scarcely, if at all, visible. It varies from a soft to a hard and dense material, closely resembling halloysite.

The first discovery of bauxite in America was in 1887, at a point a few miles northeast of Rome in Floyd County, Georgia. A few fragments of the unknown mineral were picked up on the Holland lot, two miles north of the Ridge Valley Iron Company's furnace at Hermitage. The intimate association, in this locality, of the bauxite with deposits of limestone which were being worked, led to the discovery of bauxite. Inasmuch as the bauxite fragments were highly ferruginous and deep-red in color, their discoverer, James Holland, thinking they represented an ore of iron, took them to Edward Nichols, President and Acting Chemist of the Ridge Valley Iron Company. Mr. Nichols seems to have attached no special importance to the find at the time; but, shortly afterward, he made a chemical analysis of the material. Finding it low in iron and high in alumina as compared with iron ores in general, Mr. Nichols identified the material as the mineral, bauxite. He briefly described the discovery in the Transactions of the American Institute of Mining Engineers for 1887.

The deposits on the Holland property in Floyd County were first opened and worked in April, 1888, this opening inaugurating bauxite mining in the United States. The first shipments of the ore were made in May, 1889, to the Pennsylvania Salt Company at Natrona, Pennsylvania, and to Greenwich Point near Philadelphia. The ore is said to have been used for the manufacture of both alum and metallic aluminum. In 1889, the 728 tons of ore from Georgia comprised the total output of bauxite from the United States.

Cretaceous Area

The Lower Cretacious bauxite deposits of Wilkinson County were discovered by Otto Veatch, Assistant State Geologist, on the Honeycutt property in the spring of 1907, during his study of the kaolins of that region. Although the outcrop of the Lower Cretaceous beds extends across the state in an unbroken belt from the Chattahoochee to the Savannah River, deposits of bauxite have been found only in a limited district near the central part. The greater number of the deposits, as well as the richer ones, are in Wilkinson County, but the area of bauxitic clays and of some smaller deposits is known to extend into Twiggs, Washington, and Baldwin counties.

The bauxite deposits, so far as known, are everywhere in the form of well-defined beds. The different types of ore in this region are practically the same as in the Paleozoic area.

In Wilkinson County the Lower Cretaceous beds are exposed in the valley of the Oconee River in the eastern part of the county and in the valleys of Commissioners and Big Sandy creeks almost to the southern boundary. The deposits of bauxite are found in all parts of the county and are near the contact of the Cretaceous with the unconformably-overlying Eocene beds.

The McIntyre mine, composed of the Parker-Honeycutt-Daniel group of properties, is one of the important producers of bauxite. It is 3 miles northeast of McIntyre. The mining rights on the property are held by the Republic Mining and Manufacturing Company.

According to H. K. Shearer, the bauxite is found along both sides of a small branch of Commissioners Creek as a lens near the top of the Cretaceous beds. The ore is mined less than 20 feet above the branch. It grades down into white or stained and mottled, plastic kaolin and is overlain unconformably by Eocene sands and clays. The character of the ore varies greatly.

Underneath the ore is a yellowish clay, containing a few large, soft nodules. The clay grades down into smooth plastic kaolin. Some of the kaolin is splotched with red, and the material from 17 feet below the ore is tough, plastic, maroon-colored clay.

The upper surface of the bauxite shows a distinct unconformity, approximately level over wide areas, but very irregular in detail. In places there are circular cavities, like pot holes, which are filled with Eocene clay, and some of these penetrate the entire thickness of the ore bed. The overburden in the mine consists of 4 feet of tough, sandy, blue clay, peculiarly stained and mottled with red and yellow, and several feet of gray sand, forming soil and subsoil. There is no marked bed of basal conglomerate, but the blue clay contains boulders of bauxite up to one foot in diameter, and rounded quartz pebbles up to 2 inches. The length of the face and prospective deposits exposed by exploration work is about 1,000 feet. The thickness of the ore is said to have been as much as 9 feet in the worked-out portion in the Daniel property, but the greatest thickness exposed in 1916 was 6 feet, according to Shearer. The ore to the northwest of the drier had an average thickness of 5 feet and was decidedly thinner toward the west. The ore evidently grades into kaolin laterally as well as downward.

On the Honeycutt property, about 150 yards from the mine and at the same level, red, highly ferruginous bauxite outcrops in a bed 4 feet thick.

The upper 3 feet of the bauxite bed in the mine is hard, white, finely pisolitic ore, but changes in depth into softer, iron-stained ore of similar texture, which, in turn, grades into softer kaolin and scattered nodules. The pisolites in the best part of the ore average less than one-fourth inch in diameter, but there are scattered complex pebbles some of which show a maximum diameter of 6 inches. The complex pebbles consist of numerous small, soft pisolites in a gray or brown, dense, flinty matrix. Some of the ore has a white, porous, and chalky matrix. The pisolites commonly have a thin, hard shell and a powdery center and are the same color as or a little darker than the matrix.

The following analyses show the character of the bauxite from surface samples:[82]

Aluminum oxide (Al_2O_3)	57.80	53.11	50.94
Silicon dioxide (SiO_2)	9.41	10.20	8.48
Ferric oxide (Fe_2O_3)	0.96	7.66	9.50
Titanium dioxide (TiO_2)	2.77	2.30	2.02
Ignition	29.21	26.55	27.80
	100.15	99.82	98.74
Moisture	0.35	0.35	1.94

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[82] *Shearer, H. K., the bauxite deposits of the Coastal Plain, Georgia Geol. Survey, Bull. No. 31, pp. 37, 38, 1917.

Analyses of samples from Republic Mine:

Constituents	S-64	S-65	S-66	S-67	S-68	S-69
Al_2O_3	50.15	57.91	54.15	52.03	51.56	50.75
SiO_2	23.72	10.63	14.12	18.84	22.40	23.73
Fe_2O_3	1.13	.96	1.61	2.25	2.89	2.73
FeO	.00	.00	.00	.00	.00	.00
MgO	.04	.03	.02	.00	.03	.00
CaO	.00	.02	.00	.00	.00	.00
Na_2O	.02	.04	.01	.02	.01	.00
K_2O	.05	.03	.02	.02	.02	.00
Ignition	23.10	28.70	27.50	25.26	21.34	21.33
TiO_2	2.18	1.44	2.27	1.74	2.01	2.31
P_2O_5	.00	.00	.00	.00	.00	.00
S	.09	.09	.12	.05	.01	.00
MnO	.00	.00	.00	.00	.00	.00
ZrO_2	.003	.007	---	---	---	---
BaO	.00	.00	.00	.00	.00	.00
	100.483	99.857	99.82	100.21	100.27	100.85
Moisture	.73	.38	.63	.53	.45	.37

Eocene Area

"The bauxite deposits of the Lower Eocene are associated with a horizon of plastic to indurated and nodular, white, sedimentary kaolin and white kaolinic and micaceous sand which extends from Flint River in northern Sumter County through Macon County and the eastern part of Schley County. The kaolin beds of this horizon cap the hills near Ideal, Macon County, and dip beneath the level of Flint River a little below Copperas Bluff, Sumter County. During the time of formation of these beds the depositional conditions were practically identical with those which existed during the Lower Cretaceous period."[83]

"The exact age of the kaolin and bauxite deposits cannot be stated with certainty."[84] Shearer has referred these deposits to the Midway formation, although admitting the possibility that the kaolin and bauxite may belong to the Wilcox and the overlying sands to the Claiborne formation.

The bauxite deposits consist of rather small lenses in the kaolin, and are confined to the valleys of Sweetwater, Camper, and Buck creeks. The intermediate ridges are capped by sand formations. The bauxite is a true bedded deposit, conformable with underlying and probably unconformable with the overlying beds. The Sweetwater mine of the Republic Mining and Manufacturing Company is 5½ miles by road from Andersonville.

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[83] Shearer, H. K., the bauxite deposits of the Coastal Plain, Georgia Geol. Survey, Bull. No. 31, pp. 64. 65, 1917.

[84] *Op. cit.*

Section in Sweetwater Mine:[85]

	Feet
Recent—	
7. Sandy soil	1 to 2
Wilcox formation	
6. Red and yellow, clayey sand and very pure, white sand, interbedded and crossbedded	2 to 30
(Unconformity)	
Midway formation	
5. White, plastic kaolin. The maximum overburden at the time of examination was 30 feet, and the greatest thickness of kaolin was 20 feet, reaching almost to the surface at one point. For 2 or 3 feet below the unconformity the kaolin was stained and mottled with red and purple, but the lower part of the bed was pure and exceptionally free from grit	0 to 20
4. Gradational phase, consisting of soft clay with small, soft nodules; contains also a few ferruginous concretions filled with soft granular material consisting of sulphur, marcasite, and various sulphates	1
3. Bauxite	5 to 6
2. More or less stained bauxitic kaolin, grading downward into non-bauxitic clay	?
1. Covered interval to level of the creek	20+

From 1914 to 1921 an area of 10 or 12 acres had been worked out, giving a total working face 1,400 to 1,800 feet. The mine was then abandoned because of the great overburden, which toward the close of the mining operations ranged from 45 to 55 feet in thickness. By removing 10 additional feet of overburden along the whole working face the company could have mined 125 feet farther back into the hill in known ore. To the top of the hill the overburden thickens only 25 feet; and it is reported that the hill has been prospected for a distance of 700 feet beyond the working face. Since 1921 the company has not operated the mine, but has used the surplus accumulated during the war period. At the present time, the only ore being shipped is from the Thigpen Property, near the Sweetwater Mine. The bauxite is hauled to the Sweetwater plant, dried, and rehauled to the Republic spur near Andersonville.

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[85] Shearer, H. K., the bauxite deposits of the Coastal Plain, Georgia Geol. Survey, Bull. No. 31, pp. 66, 67, 1917.

"The best portion of the ore makes up a bed 3 or 4 feet thick. It is hard and conglomeratic in appearance, consisting of nodules of rather irregular shape, varying in size up to 1½ inches, in a softer matrix which is locally iron stained. The volume of the nodules or pebbles is considerably greater than that of the matrix. When broken the nodules are seen to be compound, made up of hard, light gray, flinty material containing lighter colored and softer pisolites.

"The bauxite grades into white kaolin both upward and downward. The upper gradational phase is thin, and the distance separating hard bauxite and plastic kaolin without nodules is only 1 to 2 feet. The lower gradational clay is more coarsely nodular and extends through a much greater distance, the clay being bauxite for some feet below the floor of the mine."[86]

"The following series of analyses shows the gradation, from the overlying kaolin down to the base of the workable portion of the bed."[87]

Analyses of bauxite from Sweetwater mine:[88]

	S-109	S-110	S-111	S-112	S-113	S-114	S-115	S-116	S-117
Al_2O_3	44.18	49.55	54.58	57.13	58.82	58.06	58.38	55.64	51.48
SiO_2	34.31	23.18	16.18	9.08	5.46	6.00	8.84	14.28	22.79
Fe_2O_3	.81	2.28	.99	2.42	2.72	2.73	1.30	1.32	1.14
FeO	.29	.14	.29	.29	.14	.14	.14	.28	.14
MgO	.00	.02	.00	.04	.00	.00	.06	.00	.03
CaO	.00	.00	.00	.00	.00	.00	.00	.00	.00
Na_2O	.06	tr.	.00	tr.	.00	.00	tr.	.00	tr.
K_2O	.08	tr.	.00	tr.	.00	.00	tr.	.00	tr.
Ignition	18.16	23.28	25.58	27.75	30.26	30.21	29.25	26.84	22.58
TiO_2	1.82	1.81	2.74	3.08	2.72	3.07	1.80	1.81	1.81
	99.71	100.26	100.36	99.79	100.12	100.21	99.77	100.17	99.97
Moisture	.77	.72	.73	.67	.91	.40	.06	.44	.39

S-109 is white plastic kaolin.
S-110 is soft nodular clay.
S-111-S-117—workable bauxite.

Recent Development

In 1914, the Republic Mining and Manufacturing Company reported a small production from the Rome district in Floyd County, although the main operations of this company were at McIntyre, Wilkinson County, and east of Andersonville, Sumter County, in the central Georgia district. The National Bauxite Company also worked in the McIntyre dis-

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[86] *Op. cit.*
[87] *Op. cit.*
[88] *Op. cit.*

trict. The Cherokee Mining Company mined ore near Halls station, Bartow County.

During 1916, deposits near Cave Springs were under development by the Republic Mining and Manufacturing Company, and Asbury and Sparks; the Republic company also shipped ore from the Booger-Hollow pit near Six Mile. In the Hermitage area north of Rome, the Republic Mining and Manufacturing Company shipped bauxite from a number of deposits on the east side of Armstrong Mountain, near Hermitage; and Asbury and Sparks developed a pocket about 2½ miles south-southeast of Pinson Station.

The production of bauxite from Georgia in 1917 was approximately 52,000 tons, which included an increase of about 31 per cent over the production in 1916. The counties ranked as follows in production: Wilkinson, Sumter, Floyd, Bartow, and Meriwether. The output was used as follows: 59 per cent for alumina chemicals, 21 per cent for aluminum, and 20 per cent for abrasives. In Bartow and Floyd counties, five companies were mining bauxite from deposits near Adairsville, Cave Springs, Hall, Hermitage, Linwood, and Pinson. In addition there was a small production of chemical ore from the deposits near Warm Springs in Meriwether County. Extensions to these deposits were also found. In the central Georgia field, Sumter and Wilkinson counties produced 37,000 long tons of ore. More than 61 per cent of this material was used by the chemical industry.

Georgia produced approximately 36,500 tons of bauxite in 1918, which was 30 per cent less than the 1917 production. The counties had the following rank in output: Wilkinson, Floyd, Sumter, Bartow, Randolph, and Meriwether. The deposits near Cuthbert, Randolph County, were operated for the first time in 1918.

Georgia produced 37,201 long tons of bauxite in 1919, a slight increase over 1918. The producing counties, named in order of output, were Wilkinson, Sumter, Floyd, Bartow, Randolph, Macon, and Meriwether.

In Wilkinson County the Republic Mining and Manufacturing Company and the General Bauxite Company worked near Toomsboro. The deposits formerly worked by the du Pont interests had been mined out. The Republic Mining and Manufacturing Company was practically the only operator in Sumter County. The overburden at Sweetwater mine was reported to be hindering operations because of increasing thickness. The Republic Mining and Manufacturing Company worked deposits in Bartow, Floyd, and Meriwether counties also. The Warner Mining Company mined ore near Adairsville, Floyd County. Asbury & Sparks, who formerly operated mines in Floyd County and in Alabama, did not mine bauxite in 1919. In Macon County bauxite was produced by the Mineral Products Company and the Ideal Bauxite Company.

Georgia produced 34,397 tons of bauxite in 1920, all of which was used in the manufacture of chemicals. New mines were opened near Springvale in Randolph County. The largest producer in the State was the Republic mine, east of Andersonville in Sumter County. Wilkinson, Floyd, Randolph, Meriwether, Macon, and Bartow counties followed in the order named.

Bauxite was produced in 1921 in Sumter, Bartow, Randolph, Wilkinson, and Meriwether counties. The Republic Mining and Manufacturing Company was the largest producer, operating one mine each in Bartow, Meriwether, Sumter, and Wilkinson counties. The Kalbfleisch Bauxite Company operated mines in Bartow and Randolph counties, and the Warner Mining Company in Bartow County.

Bauxite Producers in Georgia in 1921[89]

County—	*Name and Address of Operator*	*Location of Plant or Mine*
Bartow	Kalbfleisch Corporation, 31 Union Square West, New York	Halls Station, Ga.
Bartow	Republic Mining and Manufacturing Co., 1111 Harrison Building, Philadelphia, Pa.	(Lot 90) Halls Station, Ga.
Floyd	Republic Mining and Manufacturing Co., 1111 Harrison Building, Philadelphia, Pa.	Hermitage, Ga.
Floyd	Republic Mining and Manufacturing Co., 1111 Harrison Building, Philadelphia, Pa.	Vans Valley, Ga.
Macon	Minerals Products Corp., 2234 Dime Savings Bank Building, Detroit, Mich.	Oglethorp, Ga.
Meriwether	Republic Mining and Manufacturing Co., 1111 Harrison Building, Philadelphia, Pa.	Warm Springs, Ga.
Randolph	Kalbfleisch Corporation, 31 Union Square West, New York	Springvale, Ga.
Sumter	Kalbfleisch Corporation, 31 Union Square West, New York	Andersonville, Ga.
Sumter	Republic Mining and Manufacturing Co., 1111 Harrison Building, Philadelphia, Pa.	Andersonville, Ga.
Wilkinson	Republic Mining and Manufacturing Co., 1111 Harrison Building, Philadelphia, Pa.	Irwinton, Ga.

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[89] Cave, H. S., Historical sketch of the Geological Survey of Georgia, Bibliography and other data, Georgia Geol. Survey, Bull. No. 39. p. 52, 1922.

Alabama

Location

Bauxite deposits are found in a narrow belt extending from Rock Run and Piedmont, Cherokee County, in northeastern Alabama, to Rome and Cave Springs, Floyd County, in northwestern Georgia, a distance of 120 miles. The Alabama deposits are limited, for the most part, to the Coosa Valley and are distributed over an area approximately 60 miles long. Those that have been worked are in Cherokee, Calhoun, and DeKalb counties.

The Deposits

These deposits are in the form of large pockets in a residual mantle, 100 feet or more thick, that rests upon sedimentary rocks, mainly upon the Knox dolomite. The pockets are clearly marked, are generally lenticular in shape, range from 25 to 300 feet in greatest horizontal dimensions, and vary from a few feet to more than 90 feet in depth. They are along the traces of faults—the major thrust faults of Hayes. Many of them are at the bases of grayish quartzite ridges where they are associated with red clays that have resulted from the weathering of the Knox dolomite. The presence of bauxite is indicated by the surface exposure of rounded boulders of pisolitic bauxite, numbers of which are uncovered in the cultivation of fields.

The bauxite in the pockets is mixed with irregular masses of red and white clay. Inasmuch as the ore is usually distinctly pisolitic and harder than the kaolin, the two are easily separated in mining. In some of the deposits the pisolites are harder than their matrix, and the reverse condition holds in other places.

The following are analyses of the white and red types of bauxite from the Rock Run district in Cherokee County, Alabama:[90]

White	1	2	3	4
Aluminum oxide (Al_2O_3)	58.21	61.68	61.00	61.87
Ferric oxide (Fe_2O_3)	3.60	1.20	2.20	2.38
Silicon dioxide (SiO_2)	2.90	2.10	2.10	0.40
Titanium dioxide (TiO_2)	3.40	---	3.12	---
Water (H_2O)	31.89	31.45	31.58	30.50

Red	5	6
Aluminum oxide (Al_2O_3)	40.93	53.87
Ferric oxide (Fe_2O_3)	22.60	8.16
Silicon dioxide (SiO_2)	8.99	4.52
Titanium dioxide (TiO_2)	---	---
Water (H_2O)	20.43	24.86

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[90] McCalley, Henry, Report on the Valley Regions of Alabama, Part II, The Coosa Valley Region, Geol. Survey of Alabama, pp. 779, 781, 785, 1897.

Samples 1 and 5 are from the old "Burst Up Bauxite Bank", 200 yards to the southeast of the Dyke Bank proper.

Samples 2, 3, and 6 are from the old "Washer or Taylor Bauxite Bank".

Sample 4 is from the "Warwhoop Bank", given as average sample of ore shipped May 18, 1892.

The following are analyses of samples of outcrop bauxite from Calhoun County given by McCalley:[91]

Aluminum oxide (Al_2O_3)	45.94	47.52	41.38	41.00	48.92
Ferric oxide (Fe_2O_3)	11.86	19.95	0.85	25.25	2.14
Silicon dioxide (SiO_2)	18.87	7.73	23.72	10.25	21.08
Water, combined	21.20	*a*23.57	*a*23.72	*a*21.97	*a*23.86

*a*These analyses include the hydroscopic moisture.

All the bauxite mined by the Republic Mining and Manufacturing Company is kiln-dried before shipment, but none mined by the other operators is dried. The usual method of mining is by hand, inasmuch as many of the properties have no power-driven machines. Several of the larger pits, however, are equipped with steel pumps and engines for operating the inclined hoists. Some dynamite is used to loosen the hard ore.

Many of the deposits have been worked for a number of years; and, according to Phalen, including the Dykes district, Warwhoop, Gaines Hill, and Washer banks of Cherokee County, were exhausted by 1913. A few are still being worked in a small way.

Recent Development

In 1914 and 1915 the Republic Mining and Manufacturing Company was the only operator mining ore near Rock Run in Cherokee County. The largest deposit worked by this company, 1½ miles east of Rock Run, is a pocket about 300 feet in diameter from which ore was being produced at a depth of 92 feet in 1916. The deposits near Piedmont had not been worked for several years.

During 1917 three companies were operating—the E. I. du Pont de Nemours Company at the Snider mine, 7 miles north of Piedmont; the Republic Mining and Manufacturing Company near Rock Run; and the Consolidated Mining Company near Fort Payne, DeKalb County. The production of bauxite in 1917 showed an increase of about 44 per cent over that in 1916. The output was used for the manufacture of alumina chemicals to the extent of 53 per cent; abrasives, 44 per cent; and refractories, 3 per cent.

During 1918 three companies mined bauxite—the Republic Mining and Manufacturing Company near Rock Run; the Consolidated Mining Company near Fort Payne; and the Expert Prospecting and Development Company near Talla-

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[91] *Op. cit.*

dega, Talladega County. The production in 1918 showed a decrease of about 40 per cent from that in 1917. The output was used by the chemical industry to the extent of 79 per cent; for abrasives, 17 per cent; and for refractories, 4 per cent.

During 1919 the Republic Mining and Manufacturing Company near Rock Run, and the Consolidated Mining Company near Fort Payne, were the only operators.

During 1920 and 1921 the only deposits worked were those of the Republic Mining and Manufacturing Company near Rock Run.

Production of bauxite in Alabama from 1910 to 1921:

1910— 9,517 long tons
1911— 8,848 " "
1912— 14,173 " "
1913—a27,409 " "
1914—a18,547 " "
1915—b28,245 " "
1916—b49,190 long tons
1917— 8,281 " "
1918— c7,192 " "
1919— c5,875 " "
1920— c5,632 " "
1921—

a—Georgia and Alabama are combined.
b—Georgia, Alabama, and Tennessee are combined.
c—Alabama and Tennessee are combined.

Missouri

Diaspore Deposits

Although Missouri, so far as known, possesses no bauxite deposits, there are, in Gasconade, Maries, Osage, Franklin, Crawford, and Phelps counties in the central part of the state, deposits of diaspore-bearing flint clays, containing a high percentage of alumina. These diaspore clays were discovered by Dr. W. S. Cox, who disposed of his extensive holdings to the Laclede-Christy Fire Clay Company. The deposits have been worked since 1918, and are now being worked to maximum capacity.

The following information is largely from the 51st and 52nd Biennial Report of the State Geologist of Missouri: "L. M. Richards and associates have operated the 'Red Pit' near Belle, producing a large tonnage. This material, containing from 60 to 75 per cent alumina, is utilized in the manufacture of refractories and abrasives. It has a higher alumina content than bauxite, and, in fact, higher than any other material produced in commercial quantities. It is associated with the flint clays and is usually found in limited quantities in the same pits."

During 1918 and 1919 the industry was hampered by the lack of cars for shipment. Diaspore clay was produced, however, by the following operators during those years: W. S. Cox at Hoffins, Bauers & Watkins at Rosebud, and Heidel & Toelke at Rosebud, as well as others.

"The greatest activity during 1920 and 1921 was in the development of new diaspore and flint clay deposits in Gasconade, Osage, Franklin, and Phelps counties. The continued use of diaspore in making refractories has increased the demand for this type of clay. New deposits have been opened near Linn and Mint Hill, Osage County. These deposits are from 7 to 18 miles from shipping points along the Missouri-Pacific Railroad. Other new diaspore clay deposits are known near St. James, Phelps County. High grade oolitic type clays have been discovered near Case and Gore in southern Warren County, although the typical ashy type of diaspore clay is unknown, as yet, north of the Missouri River. Additional deposits north of Owensville and east of Mount Sterling have been found."

"The Rock Island district continues to be the main productive area of both flint and diaspore clays. Owensville, Rosebud, Canaan, Gerald, Belle, and Bland are the principal shipping points. Belle is probably the largest shipping point for diaspore clays and Owensville for flint clays."

The General Chemical Company and the American Refractory Company are probably mining diaspore clay at Owensville, Gasconade County; and the General Chemical Company and Laclede-Christy Clay Products Company at Belle, Maries County. Reports from a few of the large producers of diaspore show that at least 20,000 tons were sold in 1921 at prices ranging from $1.60 to $8.00 a ton. Most of the output was consumed by the refractory-brick industry of St. Louis and vicinity. The diaspore is used also in the abrasive, chemical, and refractories industries in place of bauxite.

The diaspore clay, in its typical development, has a gray, ashy appearance and a slightly-pitted surface, which give it something of the appearance of volcanic ash. It is of medium hardness, is 50 to 75 per cent alumina, and is very low in iron. The great bulk of the material runs between 50 and 60 per cent in aluminum, according to one of the producers in the region.

Some geologists believe that the pockets of diaspore clay are present in the flint clays in old sink holes of the region. If this be the case, the aluminum has been concentrated in the diaspore as a result of some local conditions.

Ries discusses the Missouri deposits as follows:

"The most important material in these flint clay deposits is a hard oolitic clay, which is called 'rough clay' by the workmen. This material in places is harder than the flint clay and consists of small rounded bodies or oolites, the largest of which are one-sixteenth or three- thirty-seconds inch in diameter, embedded in a fine-grained groundmass. This clay is gray, brown, or buff in color, and though generally compact it shows in places a slightly pitted structure. It is not present in every deposit, and, though it does not occupy any definite position, it occurs in most places in the middle or near the top. The masses of it are of irregular shape and differ in size, and there is usually a gradation from the oolitic clay into the normal flint clay. In at least one pit there are two distinct types of oolitic clay, which form more or less distinct beds.

"This oolitic clay does not appear to have been known when Wheeler prepared his report, but it is a valuable product of the flint-clay district at the present time. Its value lies chiefly in its high percentage of alumina, which is due to the presence of the mineral diaspore ($Al_2O_3.H_2O$). Although diaspore may be present in the finer-grained normal flint clays it is probably confined chiefly to the oolitic clays.

"Under the microscope the grains of diaspore are easily recognized. They are abundant, although they vary in texture; some are very fine, but others are much coarser.

"Sections through the oolites examined under the microscope show that some of them consist of a mixture of grains of diaspore stained with iron oxide, through which extend streaks or circles of clear grains of diaspore.

"The grains of diaspore are commonly associated with abundant kaolinite, but hydromica, on the other hand, is generally rare.

"The following partial analyses of diaspore clay have been supplied by M. H. Thornberry, of the experiment station of the University of Missouri.

"Partial analyses of flint clays from Missouri:

	1	2	3	4	5	6	7
Silica (SiO_2)	11.50	18.84	10.15	6.24	3.60	1.68	13.54
Alumina (Al_2O_3)	74.03	62.69	72.87	68.02	81.68	68.96	71.83
Ferric oxide (Fe_2O_3)	.97	1.21	.84	12.48	1.32	9.28	1.21
Loss on ignition	13.20	13.77	14.95	13.10	13.72	13.77	12.71

"Mr. Thornberry states that in several analyses which he has seen, in which titanium oxide was determined, this constituent amounted to about 3 per cent.

"In the petrographic descriptions of these clays the presence of rutile is noted. Analysis No. 5, above, approaches somewhat closely to the theoretic composition of diaspore, which has 85 per cent alumina and 15 per cent water."[92]

Tennessee

Location

Bauxite deposits were discovered in Tennessee near Chattanooga during 1906; and the first ore was shipped in

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[92] Ries, H., Bayley, W. S., and others, High-grade clays of the eastern United States, U. S. Geol. Survey, Bull. 708, pp. 139-140, 1922.

1907. Three groups of Tennessee deposits are now known: the Tunnel deposits near the east end of McCallie Avenue and the Sherman Heights deposits on the southeast slope of Missionary Ridge, both near Chattanooga in Hamilton County; and the deposits near Keenburg, Carter County, in the northeastern part of the state.

Tunnel Deposits

Chattanooga is separated from the country to the east by Missionary Ridge, which rises to a height of 1,000 feet above sea-level, or approximately 300 feet above the floodplain of the Tennessee River, on which the city is built. During the construction of a tunnel through Missionary Ridge on McCallie Avenue, bauxite was encountered about 60 feet from the east end and thence some distance to the west. Lignite and variegated clays are associated with the ore. A small deposit east of the tunnel has been worked by the National Bauxite Company.

Sherman Heights Deposits

The deposits of bauxite at Sherman Heights on the southeast slope of Missionary Ridge have produced more ore than any others in Tennessee. The Perry mine has a diameter at the surface of 250 to 300 feet and was worked to a depth of more than 150 feet. The tonnage of ore removed from this one mine runs into the thousands. This ore was soft, light in color, of the pebble, oolitic, and pisolitic types, and rich in alumina and low in impurities.

Two rotary driers, having a capacity of 3 carloads a day, were used; and they reduced the weight of the ore from 10 to 12 per cent. These driers were about 40 feet in length, 2.5 and 3 feet, respectively, in diameter, and made 7 or 8 revolutions a minute. Wood and coke were used as fuels.

The ore produced was used by the chemical industries. That it was high grade chemical ore is indicated by the following analyses of representative carload lots:

Analyses of bauxite from Missionary Ridge, Tennessee:[93]

	1	2	3	4	5	6
Insoluble	12.13	11.15	11.33	11.07	13.12	12.65
Loss on ignition	28.97	30.04	30.20	30.00	30.39	30.31
Alumina (Al_2O_3)	57.56	57.63	57.37	57.83	55.11	55.50
Iron oxide (Fe_2O_3)	1.34	1.18	1.10	1.10	1.38	1.34

Keenburg Deposits

Bauxite was mined at the Gibson property, Carter County, northeast Tennessee, for the first time in 1912. The

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[93] Phalen, W. C., Bauxite and Aluminum in 1914, U. S. Geol. Survey, Mineral Resources, 1914, p. 187, 1915.

mine is about one mile northeast of Keenburg, a station on the Virginia and Southwestern Railway, and about 4 miles due north of Elizabethton, the county seat.

The bauxite deposits are on a southwest spur of Holston Mountain at an elevation of 2,200 to 2,300 feet. According to Phalen, the ore is in the residual clays of the Watauga shale (Cambrian) very near to or on a fault along which the Erwin quartzite, an earlier Cambrian formation, has been thrust over on the Watauga from the southeast. The general geology of the region has been mapped, by Keith, in the Roan Mountain Folio of the United States Geological Survey. The Keenburg deposits are almost 200 miles northeast of the bauxite at Missionary Ridge near Chattanooga and a somewhat greater distance southwest of the deposit in Botetourt County, Virginia.

As in the Georgia-Alabama fields, the ore forms large, irregular pockets in residual material. Variegated clays are associated with the bauxite as irregularly shaped masses or horses. In many places high-grade ore lies in contact with brown or red clay along an extremely sharp contact line. A little of the ore is pisolitic, but the greater part is of the oolitic variety.

Analysis of bauxite from Carter County, Tennessee:[94]

Aluminum oxide (Al_2O_3)	49.90
Ferric oxide (Fe_2O_3)	4.13
Insoluble	18.38
Water	27.59
	100.00

Recent Development

In 1914 bauxite was mined near Sherman Heights by the National Bauxite Company. There were no operations at the Tunnel deposits near Chattanooga. The Perry mine was worked in 1914, and in October the company was at work removing clay to prevent its washing upon the ore during the winter months. Two steam shovels and one Ledgerwood hoisting engine were employed in the work. Bauxite was mined at the Gibson mine near Keenburg in 1912 and 1913. In February, 1914, the National Bauxite Company sold its interests to the Watauga Mining Company, which produced ore during the remainder of the year.

In 1915 bauxite was mined in the old Perry mine by the National Bauxite Company. The mining cost was so great, however, because of clay slides that the mine was abandoned in 1916. Some bauxite was produced in 1915 and 1916 at the Gibson mine near Keenburg, Carter County.

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[94] Phalen, W. C., Bauxite and Aluminum in 1912, U. S. Geol. Survey, Mineral Resources, 1912, p. 951, 1913.

In 1917 the bauxite deposits on Missionary Ridge were idle. A small amount of ore was produced by the mines near Keenburg, but car shortage hampered operations. A new bauxite deposit was reported near Hixon, 15 miles north of Chattanooga.

In 1918 the deposits on Missisionary Ridge were not worked. A small amount of ore was mined from the deposits near Elizabethton, Carter County.

A little bauxite produced near East Chattanooga was sold in 1919; and the mines of the Watauga Mining Company near Elizabethton were operated.

The Kalbfleisch Corporation worked its mines in East Chattanooga and was the only producer of bauxite in 1920 and 1921.

Production of bauxite in Tennessee:

1913—	12,961	long tons	1917—	1,853	long tons
1914—	5,524	" "	1918—	b7,192	" "
1915—	a28,245	" "	1919—	b5,875	" "
1916—	a49,190	" "	1920—	b5,632	" "

a—Georgia, Alabama, and Tennessee combined.

b—Tennessee and Alabama combined.

California

"A deposit of unknown size, carrying nodular laterite and some material which is unquestionably bauxite, was located by L. M. Richards in Riverside County, California. The Geological Survey has also received samples of clay from southern California, which carry more than 50 per cent of alumnia and appear to be similar to the 'high alumina' clays of Missouri."[95]

New Mexico

Quoting from page 520, part 1, of the Mineral Resources for 1918, by James M. Hill: "The impression seems to have prevailed that the alunogen deposits in Grant County, New Mexico, are bauxite. These deposits were first described by Blake[a] and also in more detail in a privately printed pamphlet.[b] They were described in considerable detail by Hayes[c] who found that the deposit was a very highly altered volcanic breccia outcropping in a more or less circular area surrounded by basalt. He states that this breccia probably represents a core of an andesitic volcano which broke through the basalt flow of the surrounding region and that the alteration of the brecciated andesite was probably due

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[95] Hill, James M., Bauxite and aluminum in 1921, U. S. Geol. Survey, Mineral Resources, 1921, Part 1, p. 66, 1922.

to the escape of volcanic gases which followed the intrusion. The altered breccia Hayes shows by analyses to be 'essentially the silicate of alumina' and not bauxite. There are large quantities of alumina sulphate and iron-alumina sulphate which form as incrustations from 2 to 4 feet thick on the surface, and probably considerable soluble sulphate in the porous altered breccia. At present, however, there seems to be little possibility of utilization of this material on account of its inaccessibility."

"*a*Blake, W. P. Alunogen and bauxite of New Mexico: Am. Inst. Min. Eng. Trans., vol. 24, pp. 571-573, 1894.

"*b*Prospectus: The Alum Mountain property, New Mexico.

"*c*Hayes, C. W., the Gila River alum deposits: U. S. Geol. Survey Bull. 315, pp. 215-223, 1916."

Bauxite produced in the United States by states, 1889-1922:

<table>
<tr><th></th><th>Georgia</th><th>Alabama</th><th>Arkansas</th><th>Tennessee</th></tr>
<tr><td>1889</td><td>728</td><td>------</td><td>------</td><td>------</td></tr>
<tr><td>1890</td><td>1,844</td><td>------</td><td>------</td><td>------</td></tr>
<tr><td>1891</td><td>3,301</td><td>292</td><td>------</td><td>------</td></tr>
<tr><td>1892</td><td>5,110</td><td>5,408</td><td>------</td><td>------</td></tr>
<tr><td>1893</td><td>2,415</td><td>6,764</td><td>------</td><td>------</td></tr>
<tr><td>1894</td><td>2,050</td><td>9,016</td><td>------</td><td>------</td></tr>
<tr><td>1895</td><td>3,756</td><td>13,313</td><td>------</td><td>------</td></tr>
<tr><td>1896</td><td>7,313</td><td>11,051</td><td>------</td><td>------</td></tr>
<tr><td>1897</td><td>7,507</td><td>13,083</td><td>------</td><td>------</td></tr>
<tr><td>1898</td><td colspan="2">25,149</td><td>------</td><td>------</td></tr>
<tr><td>1899</td><td>15,736</td><td>14,499</td><td>5,045</td><td>------</td></tr>
<tr><td>1900</td><td colspan="2">19,739</td><td>3,445</td><td>------</td></tr>
<tr><td>1901</td><td colspan="2">18,038</td><td>867</td><td>------</td></tr>
<tr><td>1902</td><td colspan="2">22,677</td><td>4,645</td><td>------</td></tr>
<tr><td>1903</td><td colspan="2">22,374</td><td>25,713</td><td>------</td></tr>
<tr><td>1904</td><td colspan="2">21,913</td><td>25,748</td><td>------</td></tr>
<tr><td>1905</td><td colspan="2">15,173</td><td>32,956</td><td>------</td></tr>
<tr><td>1906</td><td colspan="2">25,065</td><td>50,267</td><td>------</td></tr>
<tr><td>1907</td><td colspan="2">34,271</td><td colspan="2">63,505</td></tr>
<tr><td>1908</td><td colspan="2">14,464</td><td colspan="2">37,703</td></tr>
<tr><td>1909</td><td colspan="2">22,227</td><td colspan="2">106,874</td></tr>
<tr><td>1910</td><td>23,579</td><td>9,517[1]</td><td colspan="2">115,836</td></tr>
<tr><td>1911</td><td>21,322</td><td>8,848[2]</td><td colspan="2">125,448</td></tr>
<tr><td>1912</td><td>19,587</td><td>14,173[3]</td><td colspan="2">126,105</td></tr>
<tr><td>1913</td><td colspan="2">27,409</td><td>169,871</td><td>12,961</td></tr>
<tr><td>1914</td><td colspan="2">18,547</td><td>195,247</td><td>5,524</td></tr>
<tr><td>1915</td><td colspan="2"><i>a</i>28,245</td><td>268,796</td><td><i>a</i></td></tr>
<tr><td>1916</td><td colspan="2"><i>a</i>49,190</td><td>375,910</td><td><i>a</i></td></tr>
<tr><td>1917</td><td>52,000</td><td>8,281[4]</td><td>506,556</td><td>1,853</td></tr>
<tr><td>1918</td><td>35,637</td><td><i>b</i>7,192</td><td>562,892</td><td><i>b</i></td></tr>
<tr><td>1919</td><td>37,201</td><td><i>b</i>5,875</td><td>333,490</td><td><i>b</i></td></tr>
<tr><td>1920</td><td>34,397</td><td><i>b</i>5,632</td><td>481,279</td><td><i>b</i></td></tr>
<tr><td>1921</td><td>------</td><td>------</td><td>124,850</td><td>------</td></tr>
<tr><td>1922</td><td>------</td><td>------</td><td>------</td><td>------</td></tr>
</table>

[4] Jones, Walter B., Statistics of the Mineral Production of Alabama for 1917, p. 10, Geol. Survey of Alabama, Bull. No. 21, 1920.

[3] Abele, Charles Arthur, Statistics of the Mineral Production of Alabama for 1912, p. 7, Geol. Survey of Alabama, Bull. No. 14, 1913.

[2] Same as [3].

[1] Abele, Charles Arthur, Statistics of the Mineral Production of Alabama for 1910, p. 9, Geol. Survey of Alabama, Bull. No. 13, 1913.

[a] Georgia, Alabama, and Tennessee combined.

[b] Alabama and Tennessee combined.

Bauxite produced and consumed in the United States, 1889-1922.

	Production		Imports		Consumption	
	Long tons	Value	Long tons	Value	Long tons	Value
1889	728	$2,366	------	------	------	------
1890	1,844	6,012	------	------	------	------
1891	3,593	11,675	------	------	------	------
1892	10,518	34,183	------	------	------	------
1893	9,179	29,507	------	------	------	------
1894	11,066	35,818	------	------	------	------
1895	17,609	44,000	------	------	------	------
1896	18,364	47,338	------	------	------	------
1897	20,590	57,652	------	------	------	------
1898	25,149	75,437	1,201	$ 4,238	25,350	$ [b]77,675
1899	35,280	125,598	6,666	23,768	39,916	[b]144,799
1900	23,184	89,676	8,656	32,697	30,840	[b]119,643
1901	18,905	79,914	18,313	67,107	36,218	[b]144,021
1902	27,322	120,366	15,790	54,410	43,112	175,875
1903	48,087	171,306	14,889	49,684	62,976	220,990
1904	47,661	235,704	15,374	49,257	63,035	285,961
1905	48,129	240,292	11,726	46,517	59,855	286,809
1906	75,332	368,311	17,809	63,221	93,141	431,532
1907	97,776	480,330	25,066	93,208	122,842	573,538
1908	52,167	263,968	21,679	87,823	73,846	351,791
1909	129,101	679,447	18,688	83,956	147,789	763,403
1910	148,932	716,258	15,669	65,743	164,601	782,001
1911	155,618	750,649	43,222	164,301	198,840	914,950
1912	158,865	768,932	26,214	95,431	186,079	864,363
1913	210,241	997,698	21,456	85,746	231,697	1,083,444
1914	219,318	1,069,194	24,844	96,500	244,162	1,165,694
1915	297,041	1,514,834	3,420	17,107	300,461	1,531,941
1916	425,100	2,296,400	30	87	[a]407,191	1,309,033
1917	568,690	3,119,058	7,691	28,989	[a]554,590	1,824,121
1918	605,721	3,447,992	3,653	14,791	[a]589,663	1,939,095
1919	376,566	2,201,747	6,082	36,820	[a]364,947	866,473
1920	521,308	3,247,345	42,895	251,284	[a]541,946	1,655,033
1921	139,550	889,800	27,587	164,589	[a]161,195	565,604
1922	------	------	------	------		

[a] Apparent domestic consumption.
[b] Exports deducted.

Domestic bauxite consumed by various industries, 1916-1921, in long tons:

	1916	1917	1918	1919	1920	1921
Aluminum ------	300,000	375,000	419,043	272,270	383,154	91,700
Chemical -------	80,000	82,000	63,896	67,842	85,878	41,000
Abrasive -------	45,000	110,000	112,908	35,395	*a*52,276	6,850
Refractory ------	------	2,400	9,874	1,059	------	------

*a*Probably includes a small quantity sold to makers of refractories.

Aluminum imported and entered for consumption in the United States from 1870 to 1891:[1]

	Quantity Pounds	Value			
June 30, 1870----	-----	$ 98	1882----	566.50	6,459
1871----	-----	341	1883----	426.25	5,079
1873----	2.00	2	1884----	595.00	8,416
1874----	683.00	2,125	1885----	439.00	4,736
1875----	434.00	1,355	Dec. 31, 1886----	452.10	5,369
1876----	139.00	1,412	1887----	1,260.00	12,119
1877----	131,00	1,551	1888----	1,348.53	14,086
1878----	251.00	2,978	1889----	998.00	4,840
1879----	284.44	3,423	1890----	2,051.00	7,062
1880----	340.75	4,042	1891----	3,906.00	6,263
1881----	517.10	6,071			

[1] Packard, R. L., Aluminum in 1891: U. S. Geol. Survey, Mineral Resources, 1891, p. 163, 1893.

Production, in pounds, of aluminum in the United States, 1883-1915:

1883------------	83	1900------------	7,150,000
1884------------	150	1901------------	7,150,000
1885------------	283	1902------------	7,300,000
1886------------	3,000	1903------------	7,500,000
1887------------	18,000	1904------------	*a*8,600,000
1888------------	19,000	1905------------	*a*11,347,000
1889------------	47,468	1906------------	*a*14,910,000
1890------------	61,281	1907------------	*a*17,211,000
1891------------	150,000	1908------------	*a*11,152,000
1892------------	259,885	1909------------	*a*34,210,000
1893------------	333,629	1910------------	*a*47,734,000
1894------------	550,000	1911------------	*a*46,125,000
1895------------	920,000	1912------------	*a*65,607,000
1896------------	1,300,000	1913------------	*a*72,379,000
1897------------	4,000,000	1914------------	*a*79,129,000
1898------------	5,200,000	1915------------	*a*99,806,000
1899------------	6,500,000		

*a*Consumption.

THE BAUXITE DEPOSITS OF MISSISSIPPI

Physiography

Mississippi may be divided into ten physiographic regions which are closely related to the underlying geologic beds. These regions differ in soil types and natural vegetation as well as in physiographic characters. They are (1) the Tennessee River Hills, (2) the Black Prairie Belt, (3) the Pontotoc Ridge, (4) the Flatwoods, (5) the North Central Plateau, (6) the Jackson Prairie Belt, (7) the Long Leaf Pine Hills, (8) the Coastal Pine Meadows, (9) the Loess or Bluff Hills, and (10) the Yazoo Delta.

Tennessee River Hills

Much of Tishomingo and Ittawamba counties in the extreme northeast part of the state is an area of rugged hills, having an altitude of 650 to 700 feet. The Tennessee valley wall is very steep, almost precipitous, and the tributary valleys are deep and narrow and have high gradients. The ruggedness is due in part, at least, to the more resistant Paleozoic beds. Toward the west and south the capping of Cretaceous sands, clays, and gravels is thicker. Consequently, in this region the hills are less precipitous, and the valleys slope more gently to the Tombigbee River.

Black Prairie Belt

Lying west of the region just described is a broad, slightly rolling belt of prairie land, which is characteristic of the belt of Selma chalk. The Black Prairies have a considerably lower elevation than the eastern hills, their altitude in the northern part being about 400 feet, from where the surface slopes to 179 feet at Macon near the southern edge of the belt. The region has a width of 10 miles in its northern part and 25 miles near Aberdeen in its southern part.

Pontotoc Ridge

This is a belt of rugged hills in the general form of a ridge, averaging more than 500 feet in elevation and bordering the west side of the northern part of the Black Prairies. The ridge is wedge-shaped, broadest in Tippah and Alcorn counties at the state line and narrowest at Houston in Chickasaw County. It separates the tributaries of the Tombigbee on the east from those of Pearl River and the Mississippi on the west. Bordering the main backbone on each side are rugged broken hills, the surfaces of which incline steeply to the lowlands of the Black Prairies on the east and to those of the Flatwoods on the west.

Flatwoods

A belt two to eight miles wide of low, flat, featureless land borders the Pontotoc Ridge on the west and skirts the western and southern margins of the Black Prairies. It is so much lower than the bordering areas that the contrast is always pronounced. The whole region has been compared to a broad river bottom. The underlying Porters Creek clay is practically impervious and resists erosion to a marked degree. At places, however, as near Pontotoc, the surface is distinctly hilly.

North Central Plateau

According to E. N. Lowe, this region embraces all the uplands of the north-central part of the state lying between the Flatwoods on the east and the Loess Bluffs, bordering the "Delta", on the west and extending from the Tennessee border south to Canton and east to Meridian. It is one of the largest physiographic provinces in the State, comprising the greater part of sixteen counties. In southern Tennessee the old plateau is still evident, but in the greater part of the region in Mississippi the topography is rough, as a result of erosion of the unconsolidated sands. The area has a maximum elevation of more than 600 feet, a point near Holly Springs on the Illinois Central Railroad being 609 feet above sea-level. The region is underlain by beds of sand and clay of the Wilcox and Claiborne series. Red sand deposits, also of Eocene age, but formerly referred to the Lafayette formation, outcrop at many places throughout the region.

Jackson Prairie Belt

South of the North-Central Plateau is a belt of gently rolling lands, having an average width of 20 miles and a maximum width of 40 miles in Yazoo and Madison counties and extending from the Loess Bluffs to the Alabama line. The region is underlain by calcareous clays, marls, and limestones of the Jackson and upper Claiborne formations.

Long Leaf Pine Hills

The whole southern half of Mississippi south of the Jackson Prairies, to within a few miles of the Gulf, is a physiographic province resembling the North Central Plateau. The area has an elevation of 400 feet in its northern part and slopes gently to the south, to less than 100 feet at its southern border. Much of the district is maturely dissected, although there are large areas of gently sloping land. The striking feature of the region is the forests of long leaf pine.

Coastal Pine Meadows

These meadows of slight relief, between the Long Leaf Pine Hills and the Gulf, commonly have an elevation of less than 50 feet. The region is characterized by marshes and swamps.

Loess or Bluff Hills

Bordering the eastern side of the Yazoo Delta and forming the old valley wall of the Mississippi River, is a series of rugged hills known as the Loess or Bluff Hills. The belt of hills, varying in width from 5 to 15 miles, extends along the edge of the "Delta" from Memphis to Vicksburg. From the latter place to the Louisiana line the Loess Bluffs, at the present time, form the east bank of the Mississippi. The Loess Hills rise 150 to 250 feet above the flood plain, have steep slopes and characteristic narrow, deep gorges. The Loess varies in thickness from 30 to 90 feet at the edge of the Bluffs, thinning to a feather edge at the eastern border of the region.

Yazoo Delta

This so-called Yazoo Delta includes the combined flood plains of the Mississippi River and its tributaries lying on the east side of the river between Memphis and Vicksburg. It is a typical low-lying, featureless flood plain having an altitude of 200 feet at the Tennessee line and 100 feet at Vicksburg. The slightly higher lands are adjacent to the streams or sloughs, the inter-stream areas being low and more or less swampy. In its western part old ox-bow lakes are rather common.

Stratigraphy

Of the five great groups of rocks, three are represented in the State of Mississippi, namely, the Paleozoic, the Mesozoic, and the Cenozoic.

Paleozoic Group

The Paleozoic beds are limited to the Devonian and Mississippian systems, which are at the surface only in the northeastern part of the state.

Devonian System

Yellow Creek beds. A series of dark gray and bluish-gray shaly limestones, having a maximum thickness of more than 100 feet, outcrop along portions of the Tennessee and tributary valleys. They have long been referred to the Devonian and have recently been called the Yellow Creek beds by E. N. Lowe. The basal portion, a few feet thick, is thicker-bedded than the remainder of the formation and contains fossils by means of which Crider was able to correlate it with the New Scotland. On the east side of the Tennessee River-Yellow Creek divide is a bed of black, carbonaceous shales which W. C. Morse has referred to the Chattanooga. His work has also raised the question whether or not other formations may be represented between these two. He is inclined to refer the upper portion of shaly limestones to the Kinderhook (Mississippian) series, but the absence of fossils save fragments of a Productid or Productella and two or three other forms makes a definite decision impossible at this time.

Mississippian System

The Mississippian system of this State has usually been divided into the Lauderdale, Tuscumbia, and Hartselle formations. In Alabama, however, the upper part has been referred to the Bangor limestone and the Hartselle sandstone, and this division may be recognized later in Mississippi.

The Lauderdale chert.—Strewn over many of the hills along the Tennessee River and its tributaries is an enormous quantity of angular chert. A few cuts reveal that the chert is stratified, the smaller amount of calcareous or dolomitic material once associated with it having been leached out of the layers, or much of this material replaced by silica. In some places the siliceous material is in the form of pulverulent silica and has been mined and shipped as scouring material, etc. The exact thickness of the formation is not known, but has been estimated to be as great as 250 feet.

The Tuscumbia limestone.—This formation consists, for the most part, of rather thick-bedded limestones. The presence of *Lithostrotion canadense,* a typical St. Louis limestone fossil, in a similar bed at Cherokee, Alabama, a few miles to the east, has resulted in the correlation of the Tuscumbia with the St. Louis.

The Hartselle sandstone. The conspicuous part of this formation is the massive bed of gray, coarse-grained sandstone, practically without bedding-planes, which forms the rugged bluffs along the upper reaches of Bear Creek. Undermining causes large blocks to break off and creep down the valley sides. The formation is said to have a thickness of 100 feet. Some of the associated beds will, no doubt, have to be referred to other divisions after more detailed study.

Mesozoic Group

The Mesozoic group has four systems: namely, the Triassic, the Jurassic, the Comanchean (Lower Cretaceous of older reports), and the Cretaceous (Upper Cretaceous). Only the last of these is represented in Mississippi.

Cretaceous System

The divisions of the Cretaceous are the Tuscaloosa, the Eutaw, the Selma, and the Ripley formations.

The Tuscaloosa formation.—The Tuscaloosa consists of irregularly-bedded, non-marine sands, clays, and gravels, the whole varying in thickness from 270 feet near Corinth, Alcorn County, to 750 or 800 feet in Monroe and Lowndes counties, near the Alabama line. In its basal part the formation consists of beds of clay, some of which are carbonaceous and lignitic and commonly contain fossil plant fragments. These clays vary in color from gray to brown and black. At many places, however, they are blotched with purples, reds, pinks, yellows, and browns. The middle part of the formation contains numerous beds of vari-colored, unconsolidated, cross-bedded sands, scattered through which are lenses of clay. Associated with the sands at many places in their outcrop are immense beds of chert gravel. In the upper part are beds of gray clays and kaolins. The Tuscaloosa lies unconformably on the Paleozoic rocks, dips toward the south and southwest at a rate of 25 to 35 feet to the mile, and forms the surface terrane over a belt 5 to 15 miles in width and from the Tennessee line to the Alabama line in length, across Tishomingo, Itawamba, Monroe, and a part of Lowndes counties.

The Eutaw formation.—Like the Tuscaloosa, the Eutaw consists of vari-colored clays and sands, the sands being distinctly micaceous and cross-bedded. It rests conformably on the Tuscaloosa, the basal of its two members being so similar to the top of the underlying formation that the division line has to be arbitrarily drawn. The upper part, the Tombigbee member, is largely a massive, glauconitic greensand or greensand marl. It contains large numbers of *Exogyra ponderosa*, a few large Ammonites, and a few other invertebrates, as well as a few disarticulated vertebrate bones. The formation outcrops in a belt 5 to 10 miles wide, lying just west of the Tuscaloosa formation and east of the Tombigbee River in Monroe and Lowndes counties.

Selma chalk.—The Selma chalk, in the main, consists of more or less argillaceous and slightly sandy limestones, rendered chalky by their large content of foraminiferal remains. It has a thickness of 950 to 1,000 feet at A. & M. College, which is in the area of its maximum development. The formation outcrops in a belt 6 to 20 miles wide, which extends nearly north and south, except near its southern end where it bends to the east. In each direction the chalk beds merge along the strike into non-chalky equivalents, which in northern Mississippi and Tennessee are included, in part, in the Tombigbee and Coffee sand members of the Eutaw formation and, in part, in the Ripley formation. As disclosed by well cuttings, the chalk seems to grade into argillaceous shales to the west of the outcrop.

Ripley formation.—The Ripley, having a thickness of 250 to 300 feet, consists of more or less calcareous and glauconitic sands, sandy clays, marls, and impure limestones, of marine origin. It rests conformably on the Selma chalk and extends in a narrow belt through western Alcorn County and eastern Tippah, Union, and Pontotoc counties to Houston, in Chickasaw County. From northern Mississippi southward along the strike the successively higher beds merge into the chalky limestones of the Selma formation, suggesting that the material has been partly reworked.

Cenozoic Group

The Cenozoic is divided into the Eocene, Oligocene, Miocene, Pliocene, Pleistocene, and Recent. All these systems are well developed in the State except the Pleistocene.

Eocene System

The Eocene in Mississippi has the following series: the Midway, the Wilcox, the Claiborne, and the Jackson.

The Midway Series

The Midway series has three divisions: (1) the Clayton formation; (2) the Porters Creek clay; and (3) the Tippah sandstone. The series has a thickness of 250 to 300 feet, and lies unconformably on the Ripley and the Selma chalk at different places in the State. It occupies a belt extending from Benton and Tippah counties on the north to Kemper County on the south.

The Clayton formation.—The Clayton is made up of (1) a basal limestone 15 to 25 feet thick, containing *Turritella mortoni* and other fossils; and (2) an overlying bed of greenish-gray, glauconitic, sandy marl 20 to 40 feet thick, which weathers to a yellowish-red sand. It extends from Tennessee to the vicinity of Houston in Chickasaw County.

The Porters Creek clay.—The Porters Creek embraces about 150 feet of dark gray clay which does not, as a rule, show distinct stratification. The clay breaks with a conchoidal fracture and has a tendency to ball up. It is nonfossiliferous, except in the eastern part of the State, where it becomes lignitic and contains indistinct leaf impressions.

The Tippah sandstone.—The Tippah consists of about 100 feet of gray sands, sandstones, and sandy clays, slightly fossiliferous at a few places and speckled with glauconite grains. The sandstones and unconsolidated sands predominate toward the top of the formation; whereas, clays are more prevalent below, grading into the gray clay of the Porters Creek at the base.

The Wilcox Series

The Wilcox series in the State as a whole has four formations: (1) the Ackerman clay, (2) the Holly Springs sand, (3) the Bashi (Woods Bluff) formation, and (4) the Hatchetigbee (Grenada) formation. It has a total thickness of 1,000 to 1,700 feet and outcrops in a broad belt extending from DeSoto, Marshall, and Benton counties on the north to Lauderdale County on the south.

The Ackerman clay.—The Ackerman consists of 600 feet of gray, more or less lignitic clay, lignite, and sand. Associated with the bluish-gray and yellowish clays are irregular lenses of concretionary iron and here and there a bed of iron carbonate varying from a few inches to a foot in thickness. The beds are well exposed in the great cut at Blanton's Gap near Ackerman, the type locality.

Section of Illinois Central Railroad cut 1½ miles east of Ackerman, Mississippi—

		Feet
Holly Springs sand		
13.	Sand, unconsolidated	7.0
12.	Sandstone	2.0
11.	Sand, unconsolidated, yellow	14.0
Ackerman clay		
10.	Clay, dark, bituminous	5.0
9.	Clay, soft shaly; at top grading into fire clay which contains some fossil plant stems and roots	8.0
8.	Clay, dark brown	1.0
7.	Clay, soft, shaly, gray	10.0
6.	Clay, dark brown band	0.5
5.	Clay, soft, shaly; containing lens-shaped iron concretions	9.0
4.	Clay, dark brown	1.0
3.	Clay, soft, shaly, white	16.0
2.	Clay, dark brown	0.5
1.	Clay, soft, shaly	6.0

Base of exposure at water falls.

The best-known deposits of iron carbonate of the Ackerman formation are in the southwest corner of Benton County in the vicinity of Winborn and Hickory Flat. The ore is confined to the dark gray and lignitic clays. The relation of the beds on the J. H. Moorehead property near Hickory Flat is shown in the following section from E. N. Lowe's report, "The Iron Ores of Mississippi".

Section on J. H. Morehead property near Winborn—

		Feet
8.	Soil, red, clay	3.0
7.	Clay, lignitic	2.0
6.	Iron carbonate, shelly, sandy	0.4
5.	Clay, gray, sandy	2.0
4.	Iron carbonate in large masses	1.2
3.	Lignite	0.5
2.	Clay, gray	12.0
1.	Clay, lignitic	6.0

The gray clays of the basal part of the formation differ but little from the underlying Porters Creek clay; and, according to E. N. Lowe, the line of division between the two formations is arbitrarily drawn, except near the Tennessee line, where the Tippah sandstone separates them. Scattered through the Ackerman as a whole, however, are beds of lignite; and the clays are more distinctly stratified and variable in character and color than those in the Porters Creek.

The Holly Springs sand.—The Holly Springs sand, having a thickness of 700 to 750 feet, is a highly cross-bedded, more or less micaceous sand, containing lenses of clay.

The Bashi (Woods Bluff) formation.—The Bashi is a glauconitic, calcareous, sandy marl, containing large calcareous concretions. It is found only near Meridian in Lauderdale County.

The Hatchetigbee (Grenada) formation.—The Hatchetigbee consists of 250 feet of lignitic clay, lignite, and sand. This formation constitutes the uppermost division of the Wilcox.

Geographic and Geologic Distribution of the Bauxite

The bauxite deposits of Mississippi are in the northern and northeastern parts of the state, in Pontotoc, Tippah, Benton, Union, Calhoun, Webster, Oktibbeha, Winston, Noxubee, and Kemper counties. They are very irregularly scattered through the belt of high hills and ridges which extends from near the Tennessee line on the north to the northwest part of Kemper County on the south, just west of the Flatwoods area. However, the main deposits are in Pontotoc, Tippah, and Benton counties. Those in Pontotoc County constitute the largest deposits and the best grade of ore in Mississippi.

The bauxite is in the Ackerman formation (basal Wilcox) near its contact with the Porters Creek clay of the Midway series. The ore is in beds which extend over considerable areas and which vary in thickness from one foot to sixteen feet. Like the deposits in central Georgia, the bauxite is interstratified with bauxitic clay, kaolin, and impure clay. In fact, the close association of all the ore, both hard and soft, with beds of clay is the most striking feature of the deposits.

PONTOTOC COUNTY

Topographic and Geologic Location

Pontotoc County, in the north central part of the state, is in parts of four physiographic regions: namely, the Black Prairie Belt, the Pontotoc Ridge, the Flatwoods, and the North Central Plateau. Characteristic respectively of the four physiographic regions are four terranes: the Selma chalk and the Ripley formation of the (upper) Cretaceous, and the Midway and the basal Wilcox series of the lower Eocene.

In the extreme eastern part, the outcrop of Selma chalk forms a belt about three miles wide extending from the north to the south side of the county. Just west of the Selma chalk the Ripley formation covers a belt four to nine miles wide. In order, in the western half of the county, the Midway and Wilcox series constitute belts respectively six to eight miles wide and three to six miles wide.

Stratigraphy

The oldest formation, the Selma chalk, and the next oldest, the Ripley, of the eastern part of the county, contain no bauxite deposits. Neither does the next succeeding terrane, the Midway series; but some of its divisions are so closely related to the bauxite-bearing Wilcox series as to make a discussion of both series essential.

The Midway series in the State as a whole consists of three formations: the Clayton, Porters Creek, and Tippah, named in the order of their age. The Clayton formation is made up of a basal limestone 15 to 25 feet thick containing *Turritella mortoni* and other fossils, and an overlying bed of greenish-gray, glauconitic, sandy marl 20 to 40 feet thick, which weathers to a yellowish-red sand. The Porters Creek clay embraces about 150 feet of dark glay which, as a rule, does not show distinct stratification. In the northern part of its outcrop there is a sandy member at the top. These clays are non-fossiliferous, except in the eastern part of the State, where they become lignitic and contain indistinct leaf impressions. The Tippah sandstone consists of about 100 feet of gray to greenish-gray sands, sandstones, and sandy clay, commonly fossiliferous and speckled with glauconite grains. The sandstones and unconsolidated sands predominate toward the top of the formation, whereas clays are more prevalent below, grading into the gray clay of the Porters Creek at the base.

The Wilcox series in the State as a whole has four formations: the Ackerman, the Holly Springs, the Bashi (Woods Bluff), and the Hatchetigbee (Grenada). The Ackerman clay consists of 600 feet of gray, more or less lignitic clay, lignite, and sand. Associated with the bluish-gray and yellowish clays are irregular lenses of concretionary iron and here and there a bed of iron carbonate varying from a few inches to a foot in thickness. The gray clays of the basal part of the formation differ but little from the underlying Porters Creek clay; and, according to E. N. Lowe, the line of division between the series is arbitrarily drawn, except near the Tennessee line, where the Tippah sandstone separates them. Beds of lignite are scattered through the Ackerman, and the clays of this formation are more distinctly stratified and variable in character and color than those of the Porters Creek. The Holly Springs, having a thickness of 700 to 750 feet, is a highly cross-bedded, more or less micaceous sand containing lenses of clay. The Bashi (Woods Bluff) formation is a glauconitic, calcareous, sandy marl containing large calcareous concretions, and is found only near Meridian in Lauderdale County. The Hatchetigbee (Grenada) formation consists of 250 feet of lignitic clay, lignite, and sand.

All these formations are typically unconsolidated beds showing no evidence of folding or faulting in the area under consideration. The normal dip is a little south of west at an average of 25 to 30 feet to the mile.

The Ore

The bauxite deposits of Pontotoc County are confined to the western tier of townships, Range 1 East, which makes up the western quarter of the county. They constitute the largest deposits and the best grade of ore in Mississippi. There are two main groups: (1) "Smoky Top" and vicinity, ten miles west of Ecru on the Gulf, Mobile, and Northern Railroad; and (2) "Big Hill" and environs, eight to nine miles due west of Pontotoc on the same railroad. The Pontotoc-Tocopola concrete road, now completed to a point within two miles of the Big Hill deposits, will permit immediate development in a small way.

The known deposits of bauxite and bauxitic clay and the prospective ones under cover have a total area in the county of more than 1,000 acres. The largest single deposit is Smoky Top which has an area of 263 acres. The deposits at Big Hill and environs, about ten miles south of Smoky Top, have a total area of 456 acres.

The ore lies near the tops of the hills, ridges, and spur ridges of the region at an elevation approximately 500 feet above sea-level (B. M. assumed), except where the monoclinal dip brings it to a lower level. The spurs and spur ridges containing ore have a relief ranging from 30 to nearly 100 feet, and many of them seem to have been held up by the hard resistant cap of bauxite ore. Consequently, the overburden is, in general, less than 10 feet and, in many places, less than 5 feet.

The bauxite in Pontotoc County, like that at other places in the State, is in the basal Wilcox (Eocene), probably in the Ackerman formation near its contact with the Porters Creek clay of the Midway. The ore is in beds which extend over considerable areas and which vary in thickness from one foot to sixteen feet. Four types of ore are found in the county: namely, the pisolitic, the oolitic, the vesicular, and the amorphous. The pisolitic or oolitic, or an association of these two varieties, makes up the ore at most of the places. The deposits are interstratified with impure clays, kaolin, and bauxitic clays. At a number of places a bluish-gray clay was encountered in the test pits below the beds of bauxite. Below this thick layer of clay, a very black, lignitic clay was found in a few of the test pits.

Smoky Top

Introduction

Smoky Top is located in Sections 20 and 29, Township 8 South, Range 1 East, 10 miles due west of Ecru on the Gulf, Mobile, and Northern Railroad. It consists of a main east-west spur ridge, having several small diverging branch spurs, known collectively as West Smoky Top; and an oval hill, known as East Smoky Top. The two are separated by a valley 300 feet in width. Both contain large deposits of bauxite, the estimated total being 350,000 to 400,000 tons.

As already stated, the bauxite at Smoky Top is in the basal Wilcox (Eocene), probably in the Ackerman formation near its contact with the Porters Creek clay of the Midway. It is in the form of beds, which are continuous over areas ranging from, at least, 500 to 1,000 feet in length. These beds vary in thickness from four to sixteen feet. The deposits are interstratified with common clays, kaolin, and bauxitic clays. At many places an excess of iron in the top part of the ore forms a hard cap, below which each successive layer of ore is softer, lighter in color, lower in impurities, and higher in aluminum oxide than the overlying one. This gradation is shown in a distinct manner in the J. R. Warren test pit No. 3 on West Smoky Top. Downward the bauxite commonly grades into bauxitic clay, kaolin, or impure clay. In some places the gradation is very gradual, the lowest layer of clay having a pisolitic structure; whereas, in others the change is very abrupt. The J. R. Warren test pit No. 5 on East Smoky Top shows a gradual gradation downward from bauxite to bauxitic clay and lastly to impure clay.

Smoky Top has an area of 263 acres and is divided among the following properties:

East Smoky Top, Section 29, Township 8 South, Range 1 East
  (1) J. R. Warren property (includes part of West Smoky Top)

West Smoky Top, Sections 20 and 29, Township 8 South, Range 1 East
  (1) J. R. Warren property (includes East Smoky Top)
  (2) Tom Lowe property
  (3) A. B. Sneed property
  (4) Oscar Sneed property
  (5) Ben Gaines property.

East Smoky Top

East Smoky Top is an oval hill 800 feet long, 400 feet wide, and 50 feet high. It seems to have been held up by the hard resistant cap portion of the bauxite; consequently, the overburden is less than ten feet over the entire hill.

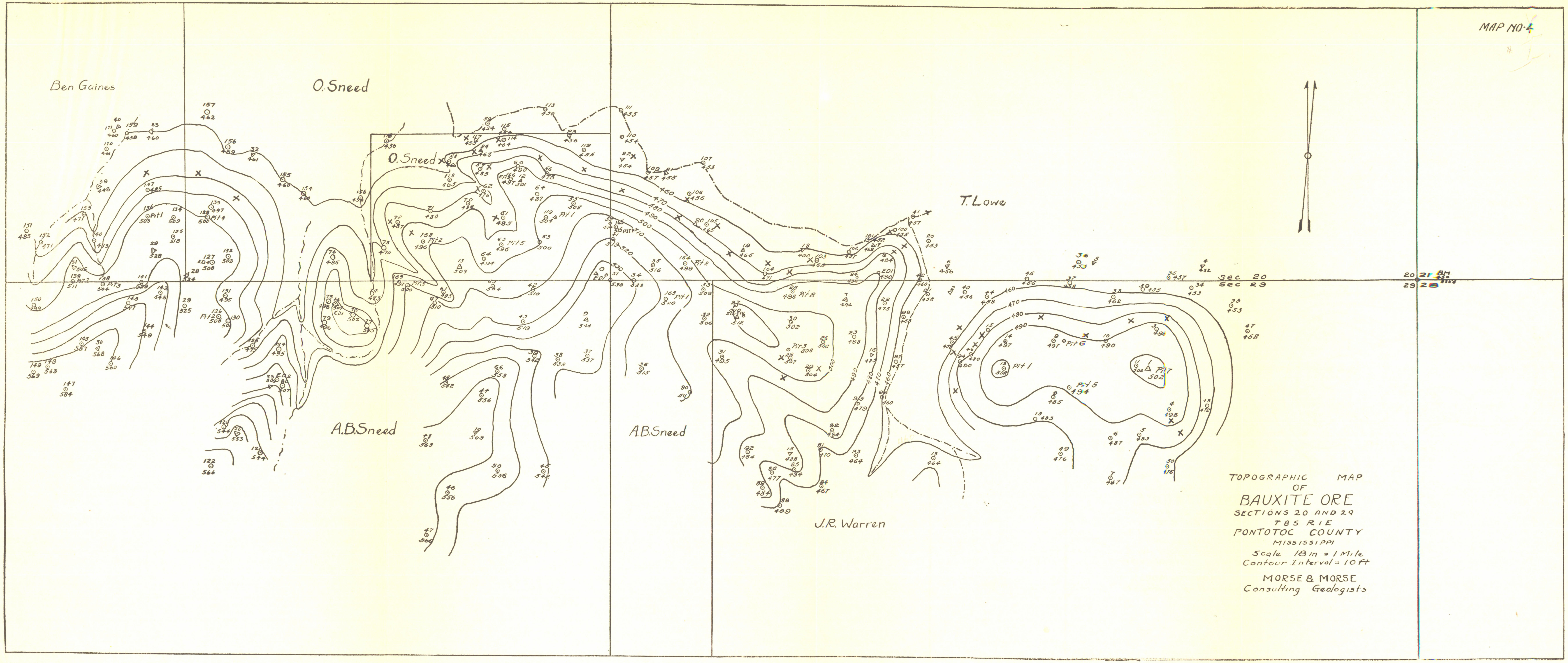
The ferruginous, pisolitic bauxite, shown by an "X" on Map 1, outcrops in a continuous bed along the west and north sides of East Smoky Top and in places along the east and south sides. Some of the blocks of ore at the outcrop are two feet thick, three feet wide, and four or five feet long. Small pieces of float are found at places on top of the hill.

J. R. Warren Property

(No. 1 in Map Section)

The J. R. Warren property, consisting of 122½ acres, is in the NE. ¼ Sec. 29, T. 8 S., R. 1 E. The farm includes all of East Smoky Top and a part of West Smoky Top.

Four test pits were sunk on the east hill to determine the thickness of the beds and the quality of the ore. Test pit No. 1 was dug on the west end of the hill. After further experience in prospecting for the ore, three additional test pits were sunk, which showed ore of much higher grade than that in No. 1. The results of the prospect work are given in the following sections of pits and analyses of samples from the pits:



TOPOGRAPHIC MAP
OF
BAUXITE ORE
SECTIONS 20 AND 29
T 8 S R 1 E
PONTOTOC COUNTY
MISSISSIPPI
Scale 18 in = 1 Mile
Contour Interval = 10 ft

MORSE & MORSE
Consulting Geologists

Section of J. R. Warren test pit No. 1

Wilcox	Feet
6. Overburden, clay	2.0
5. Bauxite, light red, irony, fragmental, and blocks of sandy iron rock	1.5
4. Clay, gray	1.0
3. Bauxite, light brown, medium soft, clayey, Sample No. 17	2.2
2. Bauxite, hard, dark red, ferruginous, Sample No. 18	6.5
1. Bauxitic clay, gray and yellowish, which grades downward into white, plastic clay	3.0

Analyses of red bauxite from J. R. Warren test pit No. 1:

	S-17	S-18
Aluminum oxide (Al_2O_3)	35.94	38.49
Ferric oxide (Fe_2O_3)	15.26	23.81
Silicon dioxide (SiO_2)	23.30	12.62
Titanium dioxide (TiO_2)	2.24	1.70
Loss on ignition	17.10	20.00
Non-volatile with HF	0.86	0.76
Moisture	6.48	1.45
	101.18	98.83

Section of J. R. Warren test pit No. 5

Wilcox	Feet
8. Overburden, clay and bauxite mixed	2.2
7. Bauxite, medium hard, red, ferruginous, Sample No. 95	1.9
6. Clay, yellow and gray, slightly bauxitic—streaks of limonite	2.6
5. Bauxite, soft, olive drab, Sample No. 96, other side of pit upper 2 feet hard, olive drab bauxite	7.1
4. Clay, gray, sticky	1.1
3. Bauxite, soft, gray, clayey. Sample No. 97	2.1
2. Bauxitic clay, gray. Sample No. 98	1.5
1. Clay, bluish-gray, and sand	2.7

Analyses of bauxite from J. R. Warren test pit No. 5:

	S-96	S-97	S-98
Aluminum oxide (Al_2O_3)	52.10	57.68	52.08
Ferric oxide (Fe_2O_3)	3.42	0.14	0.06
Silicon dioxide (SiO_2)	19.51	15.36	25.82
Titanium dioxide (TiO_2)	1.68	1.68	1.76
Loss on ignition	22.05	25.22	20.28
Non-volatile with HF	0.54	0.30	0.34
Moisture	1.08	0.60	0.43
	100.38	100.98	100.77

Section of J. R. Warren test pit No. 6

Wilcox		Feet
9.	Clay, reddish-yellow, and soil	1.7
8.	Clay, fragments of bauxite, and ferruginous material mixed	3.0
7.	Bauxite, hard, red, pisolitic. Sample No. 101	7.3
6.	Bauxite, yellowish-gray, clayey. Sample No. 102	4.0
5.	Clay, gray	0.3
4.	Bauxite, soft, yellowish-gray, clayey, Sample No. 103	1.7
3.	Clay, gray, slightly bauxitic	0.8
2.	Clay, blue—streaks of ferruginous material	2.2
1.	Clay, bluish-gray, sticky	0.5

Analyses of bauxite from J. R. Warren test pit No. 6:

	S-101	S-102	S-103
Aluminum oxide (Al_2O_3)	33.25	42.59	55.40
Ferric oxide (Fe_2O_3)	29.65	8.87	2.40
Silicon dioxide (SiO_2)	13.03	17.78	12.40
Titanium dioxide (TiO_2)	2.24	2.24	1.60
Loss on ignition	17.12	20.40	19.60
Non-volatile with HF	1.31	0.54	2.16
Moisture	3.92	8.30	8.24
	100.52	100.72	101.80

Section of J. R. Warren test pit No. 7

Wilcox		Feet
7.	Soil and clay	6.2
6.	Bauxitic clay, yellowish	2.0
5.	Bauxite, hard, reddish-green, irony, full of pisolites in places. Sample No. 104	3.5
4.	Bauxite and streaks of iron	0.8
3.	Bauxite, soft, yellowish-gray, clayey—in places the pisolites are very small. Sample No. 105	6.2
2.	Clay, hard, red, slightly sandy	0.8
1.	Clay, reddish-yellow and gray, sticky	2.0

Analyses of bauxite from J. R. Warren test pit No. 7:

	S-104	S-105
Aluminum oxide (Al_2O_3)	33.76	49.11
Ferric oxide (Fe_2O_3)	36.48	8.53
Silicon dioxide (SiO_2)	8.20	16.12
Titanium dioxide (TiO_2)	1.60	2.40
Loss on ignition	18.08	22.73
Non-volatile with HF	0.41	0.32
Moisture	2.00	1.45
	100.53	100.66

The J. R. Warren test pit No. 1 is near the west edge of the hill, 225 feet west of No. 5. A comparison of samples from pit No. 1 with samples from pit No. 5 shows that the ore near the edge of the hill is much higher in Ferric oxide than that farther back in the hill. Seemingly, the amount of Ferric oxide in the bauxite near the edge of the hill has been increased by secondary deposition from circulating ground water. Downward the ore in pit No. 5 grades from a hard ferruginous cap layer, to soft olive drab, to gray oolitic ore in a matrix of clay, to gray bauxitic clay, and, lastly, to bluish-gray, impure clay.

Ore Estimates. From Map 1 and Table 1 it is evident that the top of the highest layer of bauxite (33 per cent to 36 per cent ore) ranges from 492 to 494 feet and that the top of the second layer of bauxite (43 per cent to 47 per cent ore) ranges from 485 to 495 feet in elevation. The areas underlain by the average thickness of the respective grades of ore are estimated to contain the following tonnage:

Estimated tonnage of East Smoky Top, J. R. Warren property—

Ore, Al_2O_3	33-36 per cent	26,245 tons
Ore, Al_2O_3	39-43 per cent	23,400 tons
Ore, Al_2O_3	49-52 per cent	29,700 tons
Ore, Al_2O_3	55 per cent	12,150 tons
Total		91,495 tons

, TABLE I.—EAST SMOKY TOP

PIT		SECTION				ANALYSIS					
Name—	Elevation Feet	Description	Beds Other Feet	Beds Bauxite Feet	Sample No.	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	Loss on ignition	Moisture
J. R. Warren No. 1	502	Over burden	4.5	--	--	----	----	----	---	----	---
		Bauxite	--	2.2	17	35.94	15.26	23.30	2.24	17.10	6.48
		Bauxite	--	6.5	18	38.49	23.81	12.62	1.70	20.00	1.45
		Clay, bauxitic	3.0	--	--	----	----	----	---	----	---
J. R. Warren No. 5	494	Over burden	2.2	--	--	----	----	----	---	----	---
		Bauxite	--	1.9	95	----	----	----	---	----	---
		Clay	2.6	--	--	----	----	----	---	----	---
		Bauxite	--	7.1	96	52.10	3.42	19.51	1.68	22.05	1.08
		Clay	1.1	--	--	----	----	----	---	----	---
		Bauxite	--	2.1	97	57.68	0.14	15.36	1.68	25.22	0.60
		Clay, bauxitic	--	1.5	98	52.08	0.06	25.82	1.76	20.28	0.43
		Clay and sand	2.7	--	--	----	----	----	---	----	---
J. R. Warren No. 6	497	Over burden	4.7	--	--	----	----	----	---	----	---
		Bauxite	--	7.3	101	33.25	29.65	13.03	2.24	17.12	3.92
		Bauxite	--	4.0	102	42.59	8.87	17.78	2.24	20.40	8.30
		Clay	0.3	--	--	----	----	----	---	----	---
		Bauxite	--	1.7	103	55.40	2.40	12.40	1.60	19.60	8.24
		Clay	3.5	--	--	----	----	----	---	----	---
J. R. Warren No. 7	502	Over burden	6.2	--	--	----	----	----	---	----	---
		Bauxitic clay	2.0	--	--	----	----	----	---	----	---
		Bauxite	--	3.5	104	33.76	36.48	8.20	1.60	18.08	2.00
		Iron	0.8	--	--	----	----	----	---	----	---
		Bauxite	--	6.2	105	49.11	8.53	16.12	2.40	22.73	1.45
		Clay	2.8	--	--	----	----	----	---	----	---

West Smoky Top

West Smoky Top, an east-west spur ridge having several small diverging branch spurs, is more than 2,500 feet in length and 400 feet in average width. The ore lies near the surface in the main ridge and seems to have held the ridge up in places. Consequently, the overburden is thin over a large part of the area; but on some of the branch spurs, the relief of which ranges from 30 to over 100 feet, it is much greater.

Beginning at the east end of West Smoky Top, the beds of bauxite form a continuous outcrop for 1,500 feet along the north side of the ridge. For the next 600 feet the ridge is dissected by several small streams, beyond which the ore outcrops along the same side for several hundred feet. There are single blocks at the outcrop that are more than four feet thick, five feet wide, and eight to ten feet long. The ore varies along the outcrop from the red, ferruginous type to the high-grade olive drab and light brown varieties, which contain more than 50 per cent of aluminum oxide and small amounts of impurities, as shown by the later analyses.

J. R. Warren Property

(No. 1 in Map Section)

The J. R. Warren property, containing 122½ acres, is in the NE. ¼ Sec. 29, T. 8 S., R. 1 E. This farm includes all of East Smoky Top and the southeastern part of West Smoky Top.

In order to determine the quality of the ore and the extent of the ore-bodies in West Smoky Top two test pits and one Empire Drill well were sunk. The results of the exploration work are given in the following sections of test pits and well and analyses of samples:

Section of J. R. Warren test pit No. 2.

Wilcox		Feet
4.	Overburden, red clay and soil	4.4
3.	Bauxite, very hard, red, ferruginous. Pisolites are numerous and hard with a hard matrix. Sample No. 23	5.2
2.	Bauxite, very hard, blue, high iron. Sample No. 24	6.5
1.	Clay, blue	2.0

Analyses of red bauxite from J. R. Warren test pit No. 2:

	S-23	S-24
Aluminum oxide (Al_2O_3)	34.00	36.58
Ferric oxide (Fe_2O_3)	32.88	28.42
Silicon dioxide (SiO_2)	11.86	9.84
Titanium dioxide (TiO_2)	1.92	2.00
Loss on ignition	17.23	21.60
Non-volatile with HF	0.16	0.22
Moisture	2.75	1.72
	100.80	100.38

Section of J. R. Warren test pit No. 3

Wilcox		Feet
6.	Overburden, soil and subsoil	0.8
5.	Bauxite, hard, red, high iron. Sample No. 29	7.0
4.	Bauxite, soft, gray, low in iron. Sample No. 30	2.7
3.	Clay	1.4
2.	Bauxite, soft, gray, low in iron. Sample No. 31	3.1
1.	Clay, red, yellow, and white	3.0

Analyses of red and gray bauxite from J. R. Warren test pit No. 3:

	S-29	S-30	S-31
Aluminum oxide (Al_2O_3)	40.86	48.48	54.14
Ferric oxide (Fe_2O_3)	30.08	1.54	0.00
Silicon dioxide (SiO_2)	6.84	20.90	15.48
Titanium dioxide (TiO_2)	1.80	2.64	2.96
Loss on ignition	19.30	21.32	25.60
Moisture	2.36	4.50	1.24
	101.24	99.38	99.42

Section of J. R. Warren Empire Drill well No. 1

Wilcox		Feet
6.	Clay, red and sand	10.0
5.	Sand, red, and sand rock	2.0
4.	Clay, bauxitic, red	4.0
3.	Clay, bauxitic, yellow and gray. Sample No. 78	4.0
2.	Clay, blue and gray-stained	20.0
1.	Clay, lignitic, very black, little sand	6.0

Analysis of bauxite from J. R. Warren Drill well No. 1:

	S-78
Aluminum oxide (Al_2O_3)	41.79
Ferric oxide (Fe_2O_3)	9.51
Silicon dioxide (SiO_2)	15.76
Titanium dioxide (TiO_2)	2.70
Loss on ignition	20.20
Non-volatile with HF	2.48
Moisture	7.77
	100.21

In the J. R. Warren test pit No. 3, the cap layer of hard, red, very ferruginous bauxite, seven feet in thickness, rests on a second bed of ore that contains only 1.54 per cent of Ferric oxide; and this second layer, in turn, lies on one that has no iron in it. Thus each successively deeper layer of ore is of higher grade than the overlying one, being softer, lighter in color, lower in impurities, and higher in aluminum oxide. The J. R. Warren test pit No. 2 is 200 feet due north of No. 3 and near the north edge of the spur ridge. From a comparison of the ore with that in pit No. 3, it will be seen that the ore near the edge of the hill is much higher in Ferric oxide than that which is farther back in the hill. Seemingly, the amount of Ferric oxide originally in the bauxite near the surface and near the edge of the ridge has been increased by secondary deposition from circulating ground water.

From Map 1 and Table 2 it is apparent that the top of the bauxite in the two test pits and the Empire Drill well on this farm and in test well No. 1 on the adjoining Tom Lowe property ranges from 489 to 508 feet in elevation (B. M. assumed). The beds of ore vary in thickness from 4 to 16 feet and vary also in their content of aluminum oxide. The estimated tonnage of ore of various grades on the J. R. Warren farm is as follows:

TABLE II.—WEST SMOKY TOP

PIT		SECTION				ANALYSIS					
Name—	Elevation Feet	Description	Beds Other Feet	Beds Bauxite Feet	Sample No.	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	Loss on ignition	Moisture
J. R. Warren No. 2	498	Over burden	4.4	--	--	----	----	----	---	----	---
		Bauxite	--	5.2	23	34.00	32.88	11.86	1.92	17.23	2.75
		Bauxite	--	6.5	24	36.58	28.42	9.84	2.00	21.60	1.72
		Clay	2.0	--	--	----	----	----	---	----	---
J. R. Warren No. 3	509	Over burden	0.8	--	--	----	----	----	---	----	---
		Bauxite	--	7.0	29	40.86	30.08	6.84	1.80	19.30	2.36
		Bauxite	--	2.7	30	48.48	1.54	20.90	2.64	21.32	4.50
		Clay	1.4	--	--	----	----	----	---	----	---
		Bauxite	--	3.1	31	54.14	0.00	15.48	2.96	25.60	1.24
		Clay	3.0	--	--	----	----	----	---	----	---
J. R. Warren Empire Drill Well No. 1	512	Over burden	12.0	--	--	----	----	----	---	----	---
		Bauxite, red	--	4.0	77	26.72	21.02	24.48	1.76	13.75	2.50
		Bauxite	--	4.0	78	41.79	9.51	15.76	2.70	20.20	7.77
		Clay, blue	20.0	--	--	----	----	----	---	----	---
		Clay, lignitic	6.0	--	--	----	----	----	---	----	---
T. Lowe—Empire Drill Well No. 1	490	Over burden	1.3	--	--	----	----	----	---	----	---
		Bauxite	--	15.7	55	41.92	14.24	16.50	2.88	21.12	3.40
		Clay	13.0	--	--	----	----	----	---	----	---
T. Lowe No. 1	515	Over burden	18.2	--	--	----	----	----	---	----	---
		Clay, bauxitic	4.6	--	--	----	----	----	---	----	---
		Bauxite	--	2.7	44	32.94	31.78	10.67	1.92	18.97	3.13
		Bauxite	--	2.6	45	40.34	19.38	11.63	2.48	23.50	2.18
		Clay	3.0	--	--	----	----	----	---	----	---
Oscar Sneed No. 1	504	Over burden	10.3	--	--	----	----	----	---	----	---
		Bauxite	--	2.5	32	25.54	28.70	30.16	1.36	13.44	0.63
		Bauxite	--	3.0	33	30.43	34.29	9.28	1.68	22.06	1.87
		Bauxite	--	2.5	34	33.82	34.38	7.37	2.24	22.35	1.20
		Clay	1.0	--	--	----	----	----	---	----	---
Oscar Sneed No. 2	496	Over burden	11.5	--	--	----	----	----	---	----	---
		Clay, bauxitic	3.5	--	40	39.94	0.00	42.50	1.92	13.59	2.42
		Clay	9.3	--	--	----	----	----	---	----	---

TABLE II.—WEST SMOKY TOP—.Continued)

PIT		SECTION				ANALYSIS					
Name—	Elevation Feet	Description	Beds Other Feet	Beds Bauxite Feet	Sample No.	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	Loss on ignition	Moisture
Oscar Sneed No. 3	497	Over burden	8.3	--	--	----	----	----	---	----	---
		Clay, bauxitic	1.3	--	--	----	----	----	---	----	---
		Clay	6.5	--	--	----	----	----	---	----	---
		Clay, bauxitic	2.5	--	--	----	----	----	---	----	---
		Clay	6.0	--	--	----	----	----	---	----	---
Oscar Sneed No. 4	500	Over burden	10.6	--	--	----	----	----	---	----	---
		Clay, bauxitic	3.0	--	48	30.14	----	31.10	2.40	13.36	4.11
		Bauxite, hard	--	1.5	49	35.76	28.46	5.87	2.32	26.56	1.55
		Bauxite, soft	--	2.7	50	49.92	4.12	14.83	2.80	23.75	4.22
		Bauxite, soft	--	3.5	51	50.90	1.36	17.16	2.64	23.76	4.04
		Clay	0.3	--	--	----	----	----	---	----	---
Oscar Sneed No. 5	496	Over burden	7.9	--	--	----	----	----	---	----	---
		Clay, bauxitic	1.4	--	--	----	----	----	---	----	---
		Bauxite, soft	--	3.3	86	46.75	0.00	32.15	2.00	18.67	1.40
		Clay	1.2	--	--	----	----	----	---	----	---
		Clay, bauxitic	2.9	--	87	51.15	0.15	18.54	2.40	23.80	0.95
		Clay	3.2	--	--	----	----	----	---	----	---
Oscar Sneed Empire Drill Well No. 3	497	Over burden	11.0	--	--	----	----	----	---	----	---
		Clay, bauxitic	3.0	--	88	30.59	11.76	43.70	1.90	12.76	0.40
		Bauxite, hard	--	6.0	89	29.11	32.59	16.57	1.80	19.00	0.50
		Bauxite, hard	--	3.0	90	38.82	20.80	18.60	2.20	19.28	0.55
		Clay	2.0	--	--	----	----	----	---	----	---
		Bauxite	--	4.0	91	44.34	10.86	22.03	2.80	20.00	0.35
		Clay, blue	7.0	--	--	----	----	----	---	----	---
Ben Gaines No. 1	503	Over burden	10.0	--	--	----	----	----	---	----	---
		Clay, bauxitic	2.7	--	60	31.48	17.64	29.12	1.68	12.50	3.05
		Bauxite, soft	--	3.4	61	39.01	1.79	38.36	2.40	12.42	4.53
		Bauxite	--	8.3	63	43.07	6.93	18.90	2.00	20.15	3.80
		Clay	0.8	--	--	----	----	----	---	----	---

Ore, Al_2O_3	27 per cent	11,186 tons
Ore, Al_2O_3	35 per cent	33,500 tons
Ore, Al_2O_3	41 per cent	69,788 tons
Ore, Al_2O_3	48 per cent	9,772 tons
Ore, Al_2O_3	54 per cent	9,772 tons
Total		134,000 tons

Tom Lowe Property

(No. 1 in Map Section)

Just north of the J. R. Warren farm is the Tom Lowe property situated in the S. ½ SE. ¼ Sec. 20, T. 8 S., R. 1 E. Only about five acres in the southwest corner are underlain by bauxite, the remainder of the 70-acre farm lying in a valley to the north of and below the outcropping ore. This 5-acre tract of land forms the north side of West Smoky Top; and it is along this side that the bauxite beds have a continuous outcrop for more than 1,000 feet.

In order to determine the thickness of the beds and the quality of the ore, two test pits and one Empire Drill well were sunk. The following sections of test pits and analyses of samples show the results of the exploration work:

Section of Tom Lowe test pit No. 1

Wilcox		Feet
6.	Sand, red, and clay	14.9
5.	Clay, gray, plastic	3.3
4.	Bauxitic clay, reddish-yellow	4.6
3.	Bauxite, hard, red, ferruginous; lower 0.7 reddish-gray in color. Sample No. 44	2.7
2.	Bauxite, medium soft, bluish-gray Sample No. 45	2.6
1.	Clay, bluish-gray	3.0

Analyses of bauxite from Tom Lowe test pit No. 1:

	S-44	S-45
Aluminum oxide (Al_2O_3)	32.94	40.34
Ferric oxide (Fe_2O_3)	31.78	19.38
Silicon dioxide (SiO_2)	10.67	11.63
Titanium dioxide (TiO_2)	1.92	2.48
Loss on ignition	18.97	23.50
Non-volatile with HF	0.40	0.31
Moisture	3.13	2.18
	99.81	99.82

Section of Tom Lowe Empire Drill well No. 1

Wilcox		Feet
3.	Soil, overburden	1.3
2.	Bauxite, dark red. Sample No. 55	15.7
1.	Clay, yellow and gray	13.0

Analysis of bauxite from Tom Lowe Empire Drill well No. 1:

	S-55
Aluminum oxide (Al_2O_3)	41.92
Ferric oxide (Fe_2O_3)	14.24
Silicon dioxide (SiO_2)	16.50
Titanium dioxide (TiO_2)	2.88
Loss on ignition	21.12
Non-volatile with HF	0.21
Moisture	3.40
	100.27

In the Tom Lowe Empire Drill well No. 1, beneath only 1.3 feet of overburden, there is a single layer of dark red bauxite 15.6 feet in thickness. Below the ore are yellow and gray clays 13 feet in thickness.

In the estimate, the tonnage of the Tom Lowe property is combined with that of the Oscar Sneed property. From Map 1 and Table 2 the top of the bauxite in the Tom Lowe (pit 1) and Oscar Sneed (pit 1, pit 5, well 3) tracts is seen to range from 486 to 492 feet. With an average thickness of 7.3 feet each, the beds of ore on these two tracts (parts of farms) alone are estimated to have the following tonnage:

Tonnage of Tom Lowe and Oscar Sneed properties

Ore, Al_2O_3	32 per cent	59,956 tons
Ore, Al_2O_3	40 per cent	14,989 tons
Ore, Al_2O_3	45 per cent	14,991 tons
Total		89,936 tons

A. B. Sneed Property

(No. 1 in Map Section)

The A. B. Sneed property, consisting of 100 acres in the NW. ¼ and 17½ acres along the west side of the NE.¼ of Sec. 20, T. 8 S., R. 1 E., adjoins the J. R. Warren farm on the west, thus forming the southwestern part of West Smoky Top.

Three test pits and two Empire Drill wells were sunk on this farm without encountering any bauxite. Some bauxitic clay was found in pit No. 1 below a layer of red sand and clay. To the south the ridge rises and, as a result of the increasing overburden, only two Empire Drill wells were deep enough to really test the area. However, an enormous area adjacent to known bauxite deposits remains to be prospected. The following sections show the results of the various test pits and wells:

Section of A. B. Sneed test pit No. 1

Wilcox	Feet
3. Sand and clay, red	13.9
2. Clay, blue—in part bluish-gray, bauxitic clay with numerous oolites of ore; should contain 30-40 per cent Aluminun oxide	11.3
1. Clay, blue	3.3

Section of A. B. Sneed test pit No. 2

Wilcox	Feet
2. Soil	1.0
1. Sand, medium fine-grained	12.0

Section of A. B. Sneed test pit No. 3

Wilcox	Feet
2. Soil	1.0
1. Sand	13.0

Section of A. B. Sneed Empire Drill well No. 1

Wilcox	Feet
3. Sand and clay, red	24.0
2. Sand and clay, yellow and gray	10.0
1. Clay, dark blue; some sand	11.0

Section of A. B. Sneed Empire Drill well No. 2

Wilcox	Feet
3. Soil	1.0
2. Sand and clay, red	19.0
1. Clay, blue, micaceous, sandy	25.0

Oscar Sneed Property

(No. 1 in Map Section)

The Oscar Sneed property of 96½ acres, joining the A. B. Sneed farm on the north, is in the E.½ SW. ¼ Sec. 20, T. 8 S., R. 1 E. The southern portion of the farm, consisting of 15 acres, forms the northwestern part of West Smoky Top and is the only place on the property where bauxite is found.

The exploitation to determine the extent and quality of the bauxite deposits consisted of five test pits and three Empire Drill wells. The results of the work are given in the following sections of test pits and wells and analyses of the ore:

Section of Oscar Sneed test pit No. 1

Wilcox		Feet
5.	Overburden, sand	10.3
4.	Bauxite, reddish, clayey	2.5
3.	Bauxite, hard, red. Sample No. 33	3.0
2.	Bauxite, very hard, red. Sample No. 34	2.5
1.	Clay	1.0

Analyses of red bauxite from Oscar Sneed test pit No. 1:

	S-33	S-34
Aluminum oxide (Al_2O_3)	30.43	33.82
Ferric oxide (Fe_2O_3)	34.29	34.38
Silicon dioxide (SiO_2)	9.28	7.37
Titanium dioxide (TiO_2)	1.68	2.24
Loss on ignition	22.06	22.35
Non-volatile with HF	----	----
Moisture	1.87	1.20
	99.61	101.36

Section of Oscar Sneed test pit No. 2

Wilcox		Feet
8.	Sand and clay	4.5
7.	Bauxitic clay, gray	1.0
6.	Clay, dark gray and yellow	6.0
5.	Bauxitic clay, soft, reddish-yellow, 3.0-3.5 Sample No. 40	3.0
4.	Clay, gray	2.0
3.	Bauxitic clay, gray, slightly	2.5
2.	Clay, yellow, slightly sandy	1.5
1.	Clay, hard, gray	3.3

Analysis of bauxitic clay from Oscar Sneed test pit No. 2:

	S-40
Aluminum oxide (Al_2O_3)	39.94
Ferric oxide (Fe_2O_3)	0.00
Silicon dioxide (SiO_2)	42.50
Titanium dioxide (TiO_2)	1.92
Loss on ignition	13.59
Moisture	2.42
	100.37

Section of Oscar Sneed test pit No. 3

Wilcox		Feet
7.	Sand, red	6.8
6.	Clay, yellowish gray, sandy	1.5
5.	Bauxitic clay, gray	1.3
4.	Clay, dark gray and yellow	6.5
3.	Bauxitic clay, gray	2.5
2.	Clay and some ferruginous material	2.0
1.	Clay, yellow and gray	4.0

Section of Oscar Sneed test pit No. 4

Wilcox	Feet
8. Sand, yellow, and clay	6.0
7. Clay, gray, and sand	2.0
6. Clay, yellowish-gray	2.6
5. Bauxitic clay, yellowish-gray	3.0
4. Bauxite, hard, red. Sample No. 49	1.5
3. Bauxite, soft, yellowish-gray, oolitic, in a matrix of clay. The oolites are hard and comprise more than 60 per cent of the ore. By washing and drying this ore should grade more than 60 per cent in aluminum oxide and be low in impurities. Sample No. 50	2.7
2. Bauxite, soft, bluish-gray, oolitic, which is the same as that in bed No. 3 above. Sample No. 51	3.5
1. Clay, soft, blue, plastic	0.3

Analyses of bauxite from Oscar Sneed test pit No. 4:

	S-49	S-50	S-51
Aluminum oxide (Al_2O_3)	35.76	49.92	50.90
Ferric oxide (Fe_2O_3)	28.46	4.12	1.36
Silicon dioxide (SiO_2)	5.87	14.83	17.16
Titanium dioxide (TiO_2)	2.32	2.80	2.64
Loss on ignition	26.56	23.75	23.76
Non-volatile with HF	0.36	0.84	0.38
Moisture	1.55	4.22	4.04
	100.88	100.48	100.24

Section of Oscar Sneed test pit No. 5

Wilcox	Feet
8. Clay and sand and soil, reddish-yellow	2.9
7. Clay and sand, reddish-yellow	5.0
6. Bauxitic clay, gray	1.4
5. Bauxitic clay, soft, gray. Sample No. 86	3.3
4. Clay, gray, gummy	1.2
3. Bauxite, yellowish-gray. Sample No. 87	2.9
2. Clay, yellowish-gray, slightly bauxitic; some sand	1.0
1. Clay and sand, bluish-gray	2.2

Analyses of bauxite from Oscar Sneed test pit No. 5:

	S-86	S-87
Aluminum oxide (Al_2O_3)	46.75	51.15
Ferric oxide (Fe_2O_3)	0.00	0.15
Silicon dioxide (SiO_2)	32.15	18.54
Titanium dioxide (TiO_2)	2.00	2.40
Loss on ignition	18.67	23.80
Non-volatile with HF	----	4.76
Moisture	1.40	0.95
	100.97	101.75

Section of Oscar Sneed Empire Drill well No. 1

Wilcox	Feet
9. Soil	1.0
8. Clay, red	5.0
7. Clay, very red, sandy	10.0
6. Clay, pink, plastic	10.0
5. Sand, fine, yellow	8.0
4. Sand, dark gray	2.0
3. Clay, white, sandy	2.0
2. Clay, blue, plastic	12.0
1. Clay, blue and white, plastic	2.0

Section of Oscar Sneed Empire Drill well No. 3

Wilcox	Feet
8. Sand and clay, red	6.0
7. Clay, gray	5.0
6. Bauxitic clay, yellow. Sample No. 88	3.0
5. Bauxite, hard, red. Sample No. 89	6.0
4. Bauxite, hard, dark blue. Sample No. 90	3.0
3. Clay, blue, plastic	2.0
2. Bauxite, blue. Sample No. 91	4.0
1. Clay, blue, plastic	7.0

Analyses of bauxite from Oscar Sneed Empire Drill well No. 3:

	S-88	S-89	S-90	S-91
Aluminum oxide (Al_2O_3)	30.59	29.11	38.82	44.34
Ferric oxide (Fe_2O_3)	11.76	32.59	20.80	10.86
Silicon dioxide (SiO_2)	43.70	16.57	18.60	22.03
Titanium dioxide (TiO_2)	1.90	1.80	2.20	2.80
Loss on ignition	12.75	19.00	19.28	20.00
Moisture	0.40	0.50	0.55	0.35
	101.10	99.57	100.25	100.38

Section of Oscar Sneed Empire Drill well No. 4

Wilcox	Feet
3. Sand, red	22.0
2. Clay, black, micaceous	8.0
1. Clay, blue, micaceous	6.0

In Oscar Sneed test pit No. 4 a layer of yellowish-gray, bauxitic clay lies on a bed of hard, red bauxite, below which the ore changes abruptly to a soft, oolitic bauxite in a matrix of clay. The oolites are hard and comprise more than 60 per cent of the ore. If washed and dried, Samples Nos. 50 and 51 of the oolitic ore should grade more than 60 per cent in Aluminum oxide and be low in Ferric oxide and Silicon dioxide.

In the estimate, the tonnage of the Oscar Sneed property was combined with that of the Tom Lowe property.

Ben Gaines Property

(No. 1 in Map Section)

The Ben Gaines property, consisting of 63½ acres and adjoining the Oscar Sneed farm on the west, is on the west side of the SW. ¼ Sec. 20, T. 8 S., R. 1 E. The extreme southern portion of the farm, consisting of three acres, forms the northwest corner of West Smoky Top and is the only part of the property underlain by bauxite.

In prospecting the farm to determine the size and quality of the deposit, two test pits were sunk on the three acres. The results of the exploration are given in the following sections and analyses:

Section of Ben Gaines test pit No. 1

Wilcox	Feet
7. Soil	1.0
6. Clay and sand, reddish-yellow	6.0
5. Clay, yellowish-gray; little sand	3.0
4. Bauxitic clay, yellowish-gray. Sample No. 60	2.7
3. Bauxite, soft, gray, oolitic, in a matrix of clay. Sample No. 61	3.4
2. Bauxite, medium hard, bluish-gray, oolitic and pisolitic; contains layers of hard bauxite. Sample No. 63	8.3
1. Clay, bluish-gray, sticky	0.8

Analyses of bauxite from Ben Gaines test pit No. 1:

	S-60	S-61	S-63
Aluminum oxide (Al_2O_3)	31.48	39.01	43.07
Ferric oxide (Fe_2O_3)	17.64	1.79	6.93
Silicon dioxide (SiO_2)	29.12	38.36	18.90
Titanium dioxide (TiO_2)	1.68	2.40	2.00
Loss on ignition	12.50	12.42	20.15
Non-volatile with HF	3.12	0.44	3.02
Moisture	3.05	4.53	3.80
	98.59	98.95	97.87

Section of Ben Gaines test pit No. 2

Wilcox	Feet
2. Soil	1.0
1. Sand, yellow, medium and coarse-grained	21.0

The oolitic ore (samples Nos. 61 and 63), which has a thickness of 11.7 feet, could be washed and dried; and thus the grade of the ore be very materially raised. Inasmuch as the oolites are hard and abundant there is no question about the practicability of washing the ore.

The elevation of the top of the ore in the Oscar Sneed test pit No. 4 is 486 feet and in the Ben Gaines test pit No. 1 it is 493 feet. With an average thickness of 12.5 feet each, the deposits on the Ben Gaines property and on the adjacent part of the Oscar Sneed property are estimated to have the following tonnage:

Tonnage of Ben Gaines and Oscar Sneed properties

Ore, Al_2O_3	31 per cent	11,718 tons
Ore, Al_2O_3	38 per cent	7,814 tons
Ore, Al_2O_3	43 per cent	15,625 tons
Ore, Al_2O_3	50 per cent	11,718 tons
Total		46,875 tons

Big Hill, Second Hill, and Third Hill

H. B. Owen Property

(No. 3 in Map Section)

The H. B. Owen property, consisting of 320 acres, is in the NW. ¼, N. ½ NE. ¼, and N. ½ SW. ¼, Sec. 36, T. 9 S., R. 1 E. For convenience, the farm has been divided into three parts: Big Hill, Second Hill, and Third Hill. Big Hill proper is the farthest northeast of the three hills.

The exploitation work to determine the extent and quality of the deposits consisted of the sinking of 13 test pits.

The results of the work are shown in the sections of test pits and analyses of samples given below.

Big Hill is an oval hill 700 feet in width, 1,000 feet in length, and more than 70 feet in height. The highest point has an elevation of 504 feet (B. M. assumed); and the bauxite outcrops entirely around the hill at the 500-foot contour. The ore in the outcrop is light brown, pisolitic, and has a high content of Aluminum oxide (50-55 per cent). The known ore has a thickness of 10.5 feet and is confined to the upper part of the hill above the 490-foot contour. The overburden for the entire hill is 2 feet or less. There is a possibility that bauxite will be found in the bench which extends around the hill at an elevation of 485 feet.

Section of H. B. Owen test pit No. 1, "Big Hill' proper

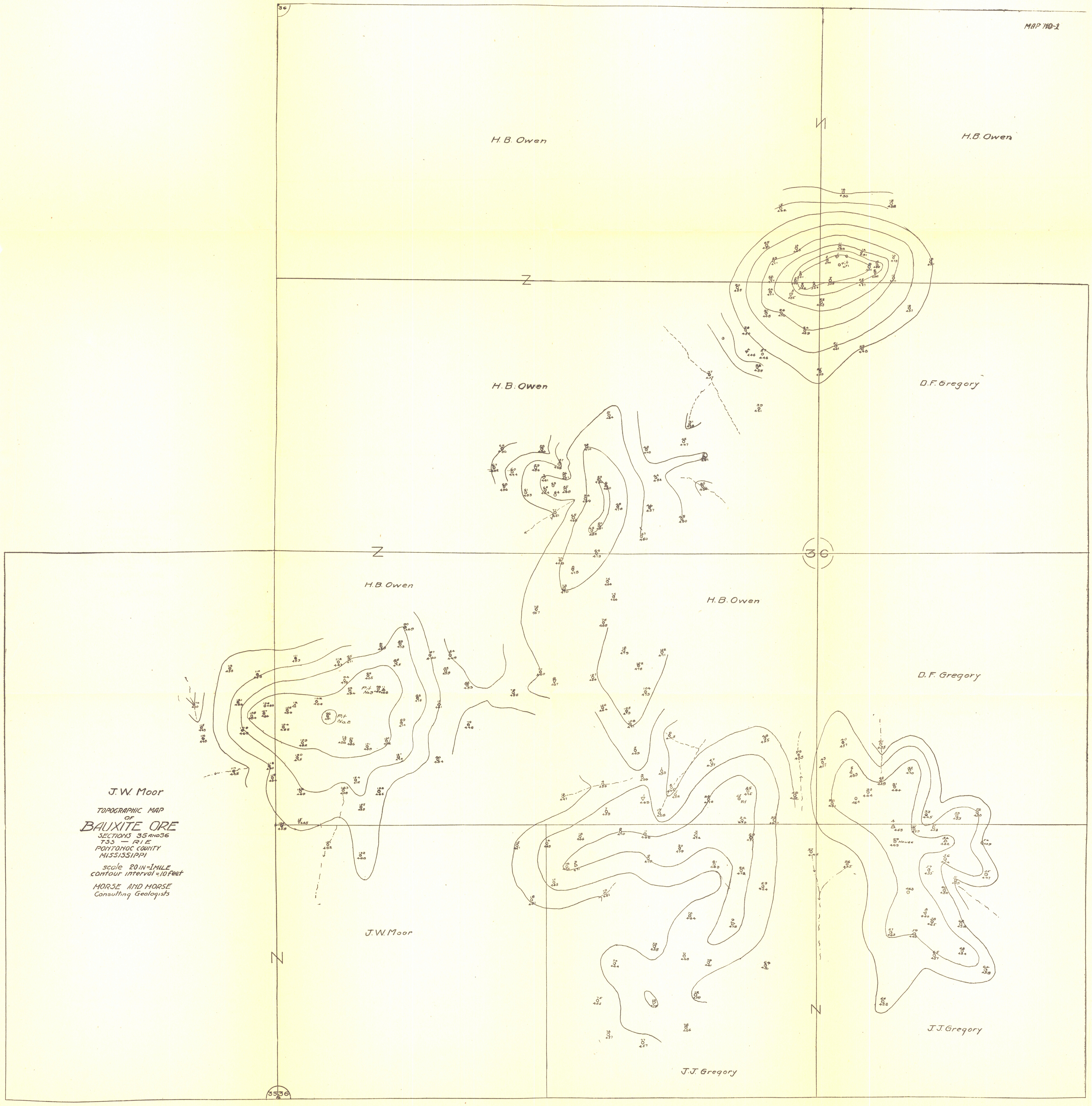
Wilcox	Feet
5. Clay overburden	2.0
4. Bauxite, high iron, red; very hard at the top, grading into softer bauxite below. Sample No. 19	6.8
3. Bauxite, hard and soft alternating; considerable iron and a little clay. Sample No. 20	3.7
2. Bauxitic clay, white and yellow	2.5
1. Lignite and lignitic clay	0.8

Analyses of bauxite from H. B. Owen test pit No. 1, "Big Hill" proper:

	S-19	S-20
Aluminum oxide (Al_2O_3)	46.10	52.86
Ferric oxide (Fe_2O_3)	11.16	5.06
Silicon dioxide (SiO_2)	15.72	18.52
Titanium dioxide (TiO_2)	1.60	1.68
Loss on ignition	21.15	20.74
Non-volatile with HF	1.98	0.47
Moisture	1.97	1.60
	99.68	100.93

The overburden in the H. B. Owen test pit No. 1 consists of 2 feet of clay. The bauxite in the pit has a thickness of 10.5 feet and is underlain by 2.5 feet of white and yellow bauxitic clay, below which is 0.8 foot of lignite and lignitic clay. There is a possibility that after further prospecting ore will be found below the bench at an elevation of 485 feet. In fact, this bench may owe its existence to the presence of a hard layer of bauxite. If additional prospecting shows ore at a lower level, the tonnage for Big Hill will be more than doubled. The bauxitic clay has not been taken into consideration in the present estimates.

MAP NO-1



TOPOGRAPHIC MAP
OF
BAUXITE ORE
SECTIONS 35 AND 36
T5S — R1E
PONTONOC COUNTY
MISSISSIPPI

scale 20 IN = 1 MILE
contour interval = 10 feet

MORSE AND MORSE
Consulting Geologists

Ore Estimates. The top of the ore in H. B. Owen test pit No. 1 has an elevation of 502 feet; and, on the basis of an average thickness of 10.5 feet for the deposit, the tonnage is estimated as follows:

Tonnage of Big Hill (H. B. Owen property)—

Ore, Al_2O_3	46 per cent	11,900 tons
Ore, Al_2O_3	53 per cent	12,333 tons
Total		24,233 tons

The hill known as Second Hill is 800 feet southwest of Big Hill, in the NW. ¼ Sec. 36, T. 9 S., R. 1 E. Bauxite outcrops along the sides and over practically the entire hill. The light brown and olive-drab ore is commonly found in large blocks along the slopes of the hill; but the ore on top of the hill consists mostly of fragments. The analyses of this outcropping ore show some of the highest grade bauxite that was found anywhere at the surface.

In the search for ore, seven test pits were sunk on the hill without success. When the topographic map of the hill was completed, the reason for the failure of the pits to penetrate ore became apparent. The highest point on the hill has an elevation of 482 feet. The bottom of the bauxite at Big Hill has an elevation of 493 feet and the bottom of the bauxitic clay an elevation of 491 feet. Even after allowance is made for the normal southwest dip of the beds, the top of the second hill is still about five feet below the bauxite. Thus a hill may have the finest kind of a showing of ore on its sides and top and still not have any bauxite in it.

The following sections show the results of the exploration and also give a general section of the beds below the bauxite:

Section of H. B. Owen test pit No. 6, Second Hill

Wilcox	Feet
3. Clay and sand, reddish-yellow	4.3
2. Clay, gray, yellow, and red, and some sand	6.0
1. Sand, yellow, micaceous, and gray clay	3.5

Section of H. B. Owen test pit No. 7, Second Hill

Wilcox	Feet
3. Clay, reddish-gray	1.8
2. Clay, gray; some sand	6.2
1. Clay, dark gray; small amount of micaceous sand	5.9

TABLE IV.—BIG HILL - THIRD HILL

PIT		SECTION				ANALYSIS					
Name—	Elevation Feet	Description	Beds Other Feet	Beds Bauxite Feet	Sample No.	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	Loss on ignition	Moisture
H. B. Owen No. 1	504	Over burden	2.0	--	--	----	----	----	---	----	---
Big Hill		Bauxite, hard	--	6.8	19	46.10	11.16	15.72	1.60	21.15	1.97
		Bauxite, hard	--	3.7	20	52.86	5.06	18.52	1.68	20.74	1.60
		Clay, bauxitic	2.5	--	--	----	----	----	---	----	---
		Lignite	0.8	--	--	----	----	----	---	----	---
H. B. Owen No. 2	491	Over burden	5.5	--	--	----	----	----	---	----	---
Third Hill		Bauxite, soft	--	1.0	21	33.30	21.74	23.16	1.76	17.18	2.10
		Bauxite, hard	--	6.3	22	32.16	34.60	9.52	1.84	19.36	2.08
		Clay	1.0	--	--	----	----	----	---	----	---
H. B. Owen No. 3	489	Over burden	4.2	--	--	----	----	----	---	----	---
Third Hill		Bauxite	--	4.0	38	35.16	20.04	23.31	2.00	16.74	2.36
		Clay	3.5	--	--	----	----	----	---	----	---
		Clay, bauxitic	1.0	--	--	----	----	----	---	----	---
		Clay	4.5	--	--	----	----	----	---	----	---
H. B. Owen No. 4	475	Over burden	2.0	--	--	----	----	----	---	----	---
Third Hill		Bauxite, hard	--	2.7	41	41.32	21.64	11.09	2.40	20.76	2.49
		Bauxite	--	1.3	42	48.26	9.80	15.47	2.40	22.60	1.98
		Clay, bauxitic	1.0	--	--	----	----	----	---	----	---
		Clay	5.0	--	--	----	----	----	---	----	---

Section of H. B. Owen test pit No. 8, Second Hill

Wilcox	Feet
2. Clay and sand, yellow	2.0
1. Sand and clay, gray and yellow, micaceous	9.5

Section of H. B. Owen test pit No. 9, Second Hill

Wilcox	Feet
2. Clay, yellowish-gray, and some sand	3.4
1. Sand, gray, micaceous, and clay and thin streaks of yellow sand	9.0

Section of H. B. Owen test pit No. 10, Second Hill

Wilcox	Feet
2. Clay and sand, reddish-yellow	3.0
1. Sand and clay, gray, micaceous	8.5

Section of H. B. Owen test pit No. 11, Second Hill

Wilcox	Feet
2. Sand and clay, gray	3.4
1. Sand and clay, gray, micaceous	8.5

Section of H. B. Owen test pit No. 12, Second Hill

Wilcox	Feet
3. Clay and sand, reddish-yellow	2.1
2. Sand and clay, gray and yellow, micaceaus	4.3
1. Sand and clay, dark gray, micaceous	3.0

Third Hill is 1,000 feet southwest of Second Hill, in the SW. 1/4 Sec. 36, T. 9 S., R. 1 E. It has a length of 1,000 feet, a width of 600 feet, and a height of 50 feet. The bauxite outcrops along the east, north, and west sides of the hill, and some fragments are found on top of it. The highest point on this hill has an elevation of 491 feet. The top of the bauxite ranges from 473 feet on the east end of the hill to 483 feet on the west side. The ore varies in thickness from 4 to 7.3 feet and contains a large amount of Ferric oxide.

The following sections of test pits and analyses of samples give the results of prospecting:

Section of H. B. Owen test pit No. 2, Third Hill

Wilcox	Feet
4. Clay overburden	5.5
3. Bauxite, soft. Sample No. 21	1.0
2. Bauxite, very hard, reddish in color grading into bluish. Sample No. 22	6.3
1. Clay, yellow	1.0

Analyses of bauxite from H. B. Owen test pit No. 2:

	S-21	S-22
Aluminum oxide (Al_2O_3)	33.30	32.16
Ferric oxide (Fe_2O_3)	21.74	34.60
Silicon dioxide (SiO_2)	23.16	9.52
Titanium dioxide (TiO_2)	1.76	1.84
Loss on ignition	17.18	19.36
Non-volatile with HF	0.80	0.32
Moisture	2.10	2.08
	100.04	99.88

Section of H. B. Owen test pit No. 3, Third Hill

Wilcox	Feet
6. Clay overburden, reddish-yellow	4.2
5. Clayey bauxite, yellowish-gray. Sample No. 38	4.0
4. Clay, red and yellow	3.5
3. Bauxitic clay, yellowish	1.0
2. Clay, red	2.5
1. Clay, yellow and gray	2.0

Analysis of bauxite from H. B. Owen test pit No. 3:

	S-38
Aluminum oxide (Al_2O_3)	35.16
Ferric oxide (Fe_2O_3)	20.04
Silicon dioxide (SiO_2)	23.31
Titanium dioxide (TiO_2)	2.00
Loss on ignition	16.74
Moisture	2.36
	99.61

Section of H. B. Owen test pit No. 4, Third Hill

Wilcox	Feet
5. Soil and clay	2.0
4. Bauxite, hard, red. Sample No. 41	2.7
3. Bauxite, reddish-yellow. Sample No. 42	1.3
2. Bauxitic clay, gray	1.0
1. Clay, gray, yellow, and red, plastic	5.0

Analyses of bauxite from H. B. Owen test pit No. 4:

	S-41	S-42
Aluminum oxide (Al_2O_3)	41.32	48.26
Ferric oxide (Fe_2O_3)	21.64	9.80
Silicon dioxide (SiO_2)	11.09	15.47
Titanium dioxide (TiO_2)	2.40	2.40
Loss on ignition	20.76	22.60
Moisture	2.49	1.98
	99.70	100.51

The H. B. Owen test pit No. 4 is on the east end of Third Hill in the outcrop of the bauxite. The top of the bauxite here has an elevation of 473 feet; and the ore is covered by 2 feet of soil and clay. The 4 feet of red and reddish-yellow bauxite is underlain by 1 foot of gray bauxitic clay. The top of the 4 feet of bauxite in test pit No. 3 has an elevation of 485 feet. The ore is underlain by 3.5 feet of red and yellow clay, 1 foot of yellowish bauxitic clay, and 4.5 feet of clay. The top of the 7.3 feet of bauxite in test pit No. 2 has an elevation of 485 feet and is underlain by 1 foot of yellow clay.

The top of the ore in the H. B. Owen test pit No. 4 is 17 to 20 feet lower than the ore at Big Hill. Inasmuch as the two deposits are a half mile apart, the normal dip of the beds is sufficient to bring the ore to this lower elevation. However, in test pits No. 3 and No. 4 the top of the ore is 12 feet higher, and in the John Wiley Moor test pit No. 1, on the west side of Third Hill, the top of the ore is 10 feet higher, than it is in the pit on the east end of the hill.

From the elevations of the bauxite (Map 3) and the thickness and composition of the ore (Table 4) in the H. B. Owen pits 2, 3, and 4, the hill is estimated to contain the following ore:

Tonnage of Third Hill (H. B. Owen Property)—

Ore, Al_2O_3	30-36 per cent	52,133 tons
Ore, Al_2O_3	40 per cent	14,667 tons
Total		66,800 tons

J. Wiley Moor

(Map 3)

When the map of the Third Hill was completed, it was found that a small area on the extreme western end of the hill was on the property of J. Wiley Moor, in the NE. ¼ SE. ¼ Sec. 35, T. 9 S., R. 1 E. The J. Wiley Moor test pit No. 1 is located on this area which is 150 feet long and 200 feet wide.

The following section shows the thickness of the ore and the analyses the quality of the material passed through in the test pit:

Section of J. Wiley Moor test pit No. 1

Wilcox	Feet
5. Overburden of red clay	3.0
4. Bauxite, red, high in iron. Sample No. 25	1.8
3. Clay, iron carbonate, and bauxite	1.5
2. Bauxite, medium hard, red; grading down into harder ore. Sample No. 26	4.5
1. Clay, red	0.5

Analyses of red bauxite from J. Wiley Moor test pit No. 1

	S-25	S-26
Aluminum oxide (Al_2O_3)	29.80	36.50
Ferric oxide (Fe_2O_3)	29.90	27.42
Silicon dioxide (SiO_2)	20.60	12.72
Titanium dioxide (TiO_2)	1.52	2.08
Loss on ignition	15.19	19.14
Moisture	2.32	1.74
	99.33	99.60

The top of the uppermost layer of bauxite in the J. Wiley Moor test pit No. 1 has an elevation of 483 feet. Sixty feet west of the pit (location No. 108 on map), the red, ferruginous, pisolitic bauxite outcrops at an elevation of 484 feet. The first layer of ore is 1.8 feet thick and is underlain by 1.5 feet of clay, iron carbonate, and bauxite. Below these is a second bed of red ore which has a thickness of 4.5 feet and which is underlain by a half foot of red clay.

From Map 3 the area of the deposit was computed. A bed 6 feet thick having such an area is estimated to contain the following tonnage:

Ore, Al_2O_3	35 per cent	4,000 tons

Section of J. Wiley Moor test pit No. 2

Wilcox		Feet
3.	Clay and sand, yellowish-gray	2.7
2.	Clay and sand, reddish-yellow and gray	6.0
1.	Sand and clay, yellowish-gray, micaceous	1.3

Inmon and Tallant Properties

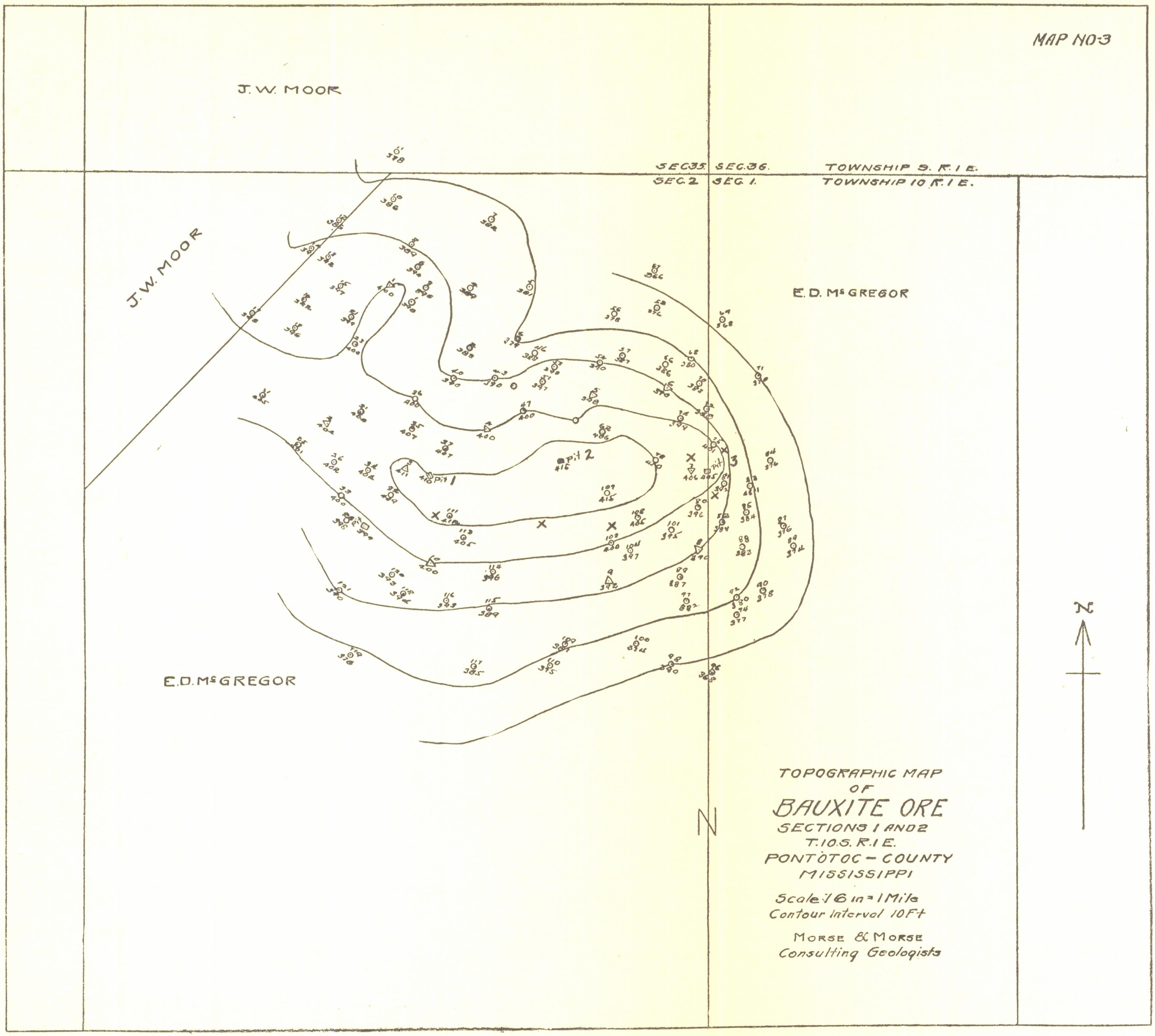
(Map 2)

The W. W. Inmon property, consisting of 76 acres, is in the W. ½ SW. ¼ Sec. 34, T. 9 S., R. 1 E. Bauxite deposits are known only in the northern part of the farm, adjoining the E. M. Tallant property.

The E. M. Tallant property, containing 160 acres, constitutes the NW. ¼ Sec. 34, T. 9 S., R. 1 E., and joins the W. W. Inmon place on the north. The bauxite deposits, however, seem to be limited to 20 acres just north of the south line. The remainder of the farm is in a large valley, below the known deposits of ore.

The prospecting to determine the extent and quality of the deposits consisted of the sinking of six test pits and two Empire Drill wells on the Inmon property and the sinking of three test pits on the Tallant farm. The following sections of test pits and analyses show the results of the exploration:

MAP NO-3



TOPOGRAPHIC MAP
OF
BAUXITE ORE
SECTIONS 1 AND 2
T. 10 S. R. 1 E.
PONTOTOC – COUNTY
MISSISSIPPI

Scale 7.6 in = 1 Mile
Contour Interval 10 Ft

Morse & Morse
Consulting Geologists

Section of W. W. Inmon test pit No. 1

Wilcox	Feet
3. Clay overburden, yellowish-white	7.1
2. Bauxite, medium hard, which extends about 1 foot higher and 1 foot lower in places. 4.1—5.0. Sample No. 36 equals 4.1 feet	4.1
1. Bauxitic clay, yellow, grading down into white plastic clay	5.7

Analysis of bauxite from W. W. Inmon test pit No. 1

	S-36
Aluminum oxide (Al_2O_3)	46.88
Ferric oxide (Fe_2O_3)	5.96
Silicon dioxide (SiO_2)	20.94
Titanium dioxide (TiO_2)	2.96
Loss on ignition	22.27
Moisture	1.32
	100.33

Section of W. W. Inmon test pit No. 2

Wilcox	Feet
5. Clay, yellow and gray	7.0
4. Sand, yellow and red, coarse-grained	6.0
3. Bauxitic clay, yellow and gray	6.0
2. Bauxite, medium hard, yellow and gray, clayey. Sample No. 39	3.4
1. Clay, yellow and gray; upper part slightly bauxitic	1.8

Analysis of bauxite from W. W. Inmon test pit No. 2

	S-39
Aluminum oxide (Al_2O_3)	50.30
Ferric oxide (Fe_2O_3)	2.30
Silicon dioxide (SiO_2)	18.26
Titanium dioxide (TiO_2)	2.80
Loss on ignition	23.34
Moisture	3.30
	100.30

Section of W. W. Inmon test pit No. 3

Wilcox	Feet
3. Sandstone, float boulders of ore, and soil	1.5
2. Bauxitic clay	10.0
1. Clay, plastic	8.8

Section of W. W. Inmon test pit No. 4

Wilcox	Feet
4. Clay, gray, slightly bauxitic	5.4
3. Clay, gray and yellow, slightly bauxitic	3.0
2. Clay, lignitic	0.8
1. Clay, gray and yellow, plastic	6.5

Section of W. W. Inmon test pit No. 5

Wilcox	Feet
3. Sand, yellow and gray, coarse-grained	8.5
2. Sand, brown and black, lignitic; upper 0.5 lignitic clay	5.0
1. Sand and clay, gray	2.5

Section of W. W. Inmon test pit No. 6

Wilcox	Feet
6. Clay, yellowish	2.9
5. Clay, dark gray	3.3
4. Bauxitic clay, gray. Sample No. 106	1.2
3. Bauxite, hard, yellowish-brown. Sample No. 107	1.6
2. Bauxite, soft, yellow. Sample No. 108	1.4
1. Clay, yellowish-gray; upper foot slightly bauxitic	4.2

Analyses of bauxite from W. W. Inmon test pit No. 6

	S-106	S-107	S-108
Aluminum oxide (Al_2O_3)	38.79	51.46	50.56
Ferric oxide (Fe_2O_3)	3.61	3.80	4.34
Silicon dioxide (SiO_2)	24.88	15.71	14.92
Titanium dioxide (TiO_2)	2.40	2.40	2.40
Loss on ignition	16.65	22.85	22.80
Non-volatile with HF	6.97	0.85	0.59
Moisture	6.07	3.00	4.90
	99.37	100.07	100.51

Section of W. W. Inmon Empire Drill well No. 1

Wilcox	Feet
4. Sand, red	34.0
3. Sand, black	4.0
2. Sand, grayish-black	6.0
1. Clay, gray, sandy	4.0

Section of W. W. Inmon Empire Drill well No. 2

Wilcox	Feet
4. Sand, red	26.0
3. Thin streak of ferruginous material	--
2. Clay, red, sandy	2.0
1. Clay, white	12.0

Section of E. M. Tallant test pit No. 1

Wilcox	Feet
5. Sand overburden, reddish	12.1
4. Clay, red	1.8
3. Clay, blue	1.5
2. Bauxite; upper 1.8 hard, reddish-yellow; lower two feet soft, bluish-gray bauxite. Sample No. 37	3.8
1. Clay, sticky, blue (caves badly)	3.8

Analysis of bauxite from E. M. Tallant test pit No. 1

	S-37
Aluminum oxide (Al_2O_3)	48.24
Ferric oxide (Fe_2O_3)	2.72
Silicon dioxide (SiO_2)	19.31
Titanium dioxide (TiO_2)	3.20
Loss on ignition	24.70
Moisture	1.44
	99.61

Section of E. M. Tallant test pit No. 2

Wilcox	Feet
4. Clay, reddish-yellow and white	6.0
3. Bauxite, medium hard, stony. Sample No. 35	4.0
2. Bauxite, soft; extends 0.6 foot lower than where sample was taken	0.6
1. Clay	4.5

Analysis of bauxite from E. M. Tallant test pit No. 2

	S-35
Aluminum oxide (Al_2O_3)	47.50
Ferric oxide (Fe_2O_3)	5.12
Silicon dioxide (SiO_2)	20.16
Titanium dioxide (TiO_2)	2.88
Loss on ignition	22.00
Moisture	2.31
	99.97

Section of E. M. Tallant test pit No. 3

Wilcox	Feet
5. Clay and sand, yellow and red in color	6.1
4. Bauxitic clay	1.5
3. Bauxite, medium hard, grayish-yellow. Sample No. 43	4.8
2. Bauxitic clay, yellow; probably contains almost as much Al_2O_3 as bed No. 3	1.5
1. Clay, blue, plastic	5.0

Analysis of bauxite from E. M. Tallant test pit No. 3

	S-43
Aluminum oxide (Al_2O_3)	49.32
Ferric oxide (Fe_2O_3)	3.92
Silicon dioxide (SiO_2)	15.53
Titanium dioxide (TiO_2)	3.36
Loss on ignition	23.54
Non-volatile with HF	0.80
Moisture	3.39
	99.86

The top of the bauxite in the E. M. Tallant test pit No. 3 is 507 feet and in the W. W. Inmon No. 2 it is 488 feet; thus the bed of ore has a southwest dip of 19 feet in a horizontal distance of 700 feet. However, there are six feet of bauxitic clay above the bauxite in the W. W. Inmon test pit No. 2. If the bed of ore continues to dip at the same angle, it is not surprising that no ore was found in the Inmon test pits No. 3 and No. 4, because these pits are not deep enough to penetrate the ore.

The ore in the E. M. Tallant Pits 1, 2, and 3 and in the W. W. Inmon Pits 1, 2, and 6 ranges from 488 to 507 feet in elevation (Map 2) and from 47 to 51 per cent in aluminum oxide (Table 3). The tonnage in these two tracts is estimated to be:

Tonnage of W. W. Inmon and E. M. Tallant Properties—

Ore, Al_2O_3	47 to 51 per cent	81,317 tons

Section of W. W. Inmon Empire Drill well No. 3

Wilcox	Feet
3. Sand, red	40.0
2. Sand, gray	4.0
1. Sand, red	6.0

Section of W. W. Inmon Empire Drill well No. 4

Wilcox	Feet
2. Sand, red	28.0
1. Sand, yellow	12.0

TABLE III.—INMON AND TALLANT

PIT		SECTION				ANALYSIS					
Name—	Elevation Feet	Description	Beds Other Feet	Beds Bauxite Feet	Sample No.	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	Loss on ignition	Moisture
E. M. Tallant No. 1	516	Over burden	15.4	--	--	----	----	----	---	----	---
		Bauxite, soft	--	3.8	37	48.24	2.72	19.31	3.20	24.70	1.44
		Clay	3.8	--	--	----	----	----	---	----	---
E. M. Tallant No. 2	505	Over burden	6.0	--	--	----	----	----	---	----	---
		Bauxite	--	4.6	35	47.50	5.12	20.16	2.88	22.00	2.31
		Clay	4.5	--	--	----	----	----	---	----	---
E. M. Tallant No. 3	515	Over burden	6.1	--	--	----	----	----	---	----	---
		Clay, bauxitic	1.5	--	--	----	----	----	---	----	---
		Bauxite	--	4.8	43	49.32	3.92	15.53	3.36	23.54	3.39
		Clay, bauxitic	1.5	--	--	----	----	----	---	----	---
		Clay, blue	5.0	--	--	----	----	----	---	----	---
W. W. Inmon No. 1	498	Over burden	7.1	--	--	----	----	----	---	----	---
		Bauxite	--	5.0	36	46.88	5.96	20.94	2.96	22.27	1.32
		Clay, bauxitic	2.0	--	--	----	----	----	---	----	---
		Clay, white	3.7	--	--	----	----	----	---	----	---
W. W. Inmon No. 2	507	Over burden	13.0	--	--	----	----	----	---	----	---
		Clay, bauxitic	6.0	--	--	----	----	----	---	----	---
		Bauxite	--	3.4	39	50.30	2.30	18.26	2.80	23.34	3.30
		Clay	1.8	--	--	----	----	----	---	----	---
W. W. Inmon No. 6	506	Over burden	6.2	--	--	----	----	----	---	----	---
		Clay, bauxitic	1.2	--	106	38.79	3.61	24.88	2.40	16.65	6.07
		Bauxite, hard	--	1.6	107	51.46	3.80	15.71	2.40	22.85	3.00
		Bauxite, soft	--	1.4	108	50.56	4.34	14.92	2.40	22.80	4.90
		Clay	4.2	--	--	----	----	----	---	----	---

Section of W. W. Inmon Empire Drill well No. 5

		Feet
Wilcox		
4.	Clay, red and yellow	6.0
3.	Clay, yellow and gray	12.0
2.	Clay, dark gray, sandy, micaceous	6.0
1.	Clay, black, micaceous	8.0

Section of W. W. Inmon test pit No. 7 on north side of Tocopola road. S. side SW. ¼ SW. ¼ Sec. 35, T. 9 S., R. 1 E.

		Feet
Wilcox		
4.	Clay, reddish-yellow, and sand	4.9
3.	Clay, yellow and gray, and sand	3.5
2.	Clay, yellowish-gray, with pisolitic structure	1.5
1.	Clay, yellowish-gray, and sand	5.5

E. D. McGregor Property

(Map 4)

The E. D. McGregor property, containing 115 acres, consists of 40 acres on the west side of the NW. ¼ Sec. 1 and 75 acres in the East ½ NE. ¼ Sec. 2, T. 10 S., R. 1 E. The main hill of bauxite in the NE. ¼ of Sec. 2 has practically a continuous outcrop of brown, pisolitic ore along its south and east sides. The hill is 900 feet long, 500 feet wide, and 40 feet high and contains deposits of bauxite in its upper part.

The prospecting to determine the quantity and quality of the ore consisted of the sinking of three test pits. The results of the investigation are given in the following sections of test pits and analyses of samples:

Section of E. D. McGregor test pit No. 1

		Feet
3.	Overburden, soil and sub-soil	1.0
Wilcox		
2.	Bauxite, somewhat shelly, olive drab. Sample No. 16	5.0
1.	Bauxitic clay	6.2

Analysis of bauxite from E. D. McGregor test pit No. 1

	S-16
Aluminum oxide (Al_2O_3)	42.33
Ferric oxide (Fe_2O_3)	9.25
Silicon dioxide (SiO_2)	21.68
Titanium dioxide (TiO_2)	1.50
Loss on ignition	19.45
Non-volatile with HF	1.50
Moisture	5.24
	100.95

Section of E. D. McGregor test pit No. 2

		Feet
	4. Overburden loam	1.0
Wilcox		
	3. Bauxite, medium hard, red, and light concretions. Sample No. 27	3.4
	2. Bauxite, clayey. Sample No. 28	0.8
	1. Clay, mostly red, and a little white clay	5.4

Analyses of bauxite from E. D. McGregor test pit No. 2

	S-27	S-28
Aluminum oxide (Al_2O_3)	47.33	34.64
Ferric oxide (Fe_2O_3)	6.87	10.40
Silicon dioxide (SiO_2)	21.94	31.86
Titanium dioxide (TiO_2)	2.24	2.56
Loss on ignition	20.33	19.12
Moisture	2.08	1.79
	100.79	100.37

Section of E. D. McGregor test pit No. 3

		Feet
	4. Soil	0.5
Wilcox		
	3. Bauxite, hard, yellowish-brown. Sample No. 109	1.2
	2. Bauxite, light brown, medium hard; some white clay pisolites. Sample No. 109 includes both No. 2 and No. 3	3.5
	1. Clay, some reddish-gray; shows pisolitic structure with pisolites of clay. Yellowish-gray clay and a few streaks of concretionary iron ore	4.6

Analysis of bauxite from E. D. McGregor test pit No. 3

	S-109
Aluminum oxide (Al_2O_3)	49.65
Ferric oxide (Fe_2O_3)	9.47
Silicon dioxide (SiO_2)	11.86
Titanium dioxide (TiO_2)	2.56
Loss on ignition	24.92
Non-volatile with HF	0.48
Moisture	1.62
	100.56

On the E. D. McGregor place the bauxite outcrops south of test pits No. 1 and No. 2 and at test pit No. 3. The overburden in all three of the pits is one foot or less. The top of the ore has an elevation of 409 feet in pit No. 1, of 414 feet in pit No. 2, and of 404 feet in pit No. 3. However, the top of the outcrop of bauxite, 100 feet south of pit No. 1, has

TABLE V.—E. D. McGREGOR

PIT		SECTION			ANALYSIS						
Name—	Elevation Feet	Description	Beds Other Feet	Beds Bauxite Feet	Sample No.	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	Loss on ignition	Moisture
E. D. McGregor No. 1	410	Over burden	1.0	--	--	----	----	----	---	----	---
		Bauxite	--	5.0	16	42.33	9.25	21.68	1.50	19.45	5.24
		Clay, bauxitic	6.2	--	--	----	----	----	---	----	---
E. D. McGregor No. 2	415	Over burden	1.0	--	--	----	----	----	---	----	---
		Bauxite	--	3.4	27	47.33	6.87	21.94	2.24	20.33	2.08
		Bauxite, clayey	--	0.8	28	34.64	10.40	31.86	2.56	19.12	1.79
		Clay	5.4	--	--	----	----	----	---	----	---
E. D. McGregor No. 3	405	Over burden	0.5	--	--	----	----	----	---	----	---
		Bauxite	--	4.7	109	49.65	9.47	11.86	2.56	24.92	1.62
		Clay	4.6	--	--	----	----	----	---	----	---

an elevation of 412 feet, or, in other words, is three feet higher than in the pit. An outcrop of ore 35 feet west of pit No. 3 has an elevation of 406 feet. At the highest point on the hill (415) the top of the bauxite also has its greatest elevation. The bottom of the ore in test pit No. 1 has the same elevation as the top of the ore in pit No. 3, suggesting the possibility that the ore in pit No. 3 is a second bed. Test pit No. 2 stopped above this second bed of ore, or just above where it should be. The presence of a second bed of ore is also suggested by the fact that the top of the 6.2 feet of bauxitic clay in pit No. 1 has the same elevation as the top of the bauxite in No. 3. A second bed of ore or a greater thickness of the bed would greatly increase the tonnage of this hill.

From the elevations of the bauxite in the E. D. McGregor pits 1, 2, and 3 (Map 4) and the composition of the ore (Table 5) the quantity is estimated as follows:

Tonnage of E. D. McGregor property

Ore, Al_2O_3	42 per cent	7,000 tons
Ore, Al_2O_3	47-50 per cent	18,240 tons
Total		25,240 tons

E. D. McGregor Property No. 2

The hill with numerous float boulders on its sides is a short distance south of J. J. Gregory's south line and is in the NE. ¼ Sec. 1, T. 10 S., R. 1 E. Pit No. 4 is on the western side of the hill above the outcrop of float boulders. Test pit No. 5 is 200 feet east of No. 4, at a slightly higher elevation. Test pit No. 6 is on the eastern side of the hill, 250 feet east of No. 5. This pit is in the midst of float ore, which is hard, brown, pisolitic bauxite. No ore was found in any of these pits, although, from the surface indications, one would expect the hill to contain a large quantity of bauxite of good grade.

Section of E. D. McGregor test pit No. 4. Location—a short distance south of J. J. Gregory's south line.

Wilcox	Feet
2. Clay, reddish and yellowish, and some sand	4.0
1. Clay, dark gray, micaceous, and sand	8.8

Section of E. D. McGregor test pit No. 5. Location—200 feet east of No. 4.

Wilcox	Feet
Clay, yellow and gray, micaceous, and sand	11.4

Section of E. D. McGregor test pit No. 6. Location—250 feet east of No. 5.

Wilcox		Feet
2.	Clay, yellowish-red, and sand	2.0
1.	Clay, yellow and gray, micaceous	7.5

Section of E. D. McGregor test pit No. 7. Location—500 feet north of Tocopola Road.

Wilcox		Feet
2.	Clay, reddish-yellow, and sand	3.5
1.	Clay, gray, micaceous, and sand	6.0

O. D. Gray Property

The O. D. Gray property, containing 155 acres, is in the NE. ¼ Sec. 20, T. 8 S., R. 1 E. There are only a few boulders of hard, reddish-brown, pisolitic bauxite outcropping on this farm. Test pit No. 1 is one-fourth mile north of the Williams house, on the side of the hill, and 12 feet above the outcrop. It passed through 14 feet of reddish-yellow clay and yellowish-gray clay containing a little sand. Test pit No. 2 is 100 feet east of No. 1, near a small branch where several boulders of hard ore outcrop four feet below the mouth of the pit, which is 10.3 feet deep. At a depth of 5.5 feet a layer of lignitic clay and sand was encountered. There is neither bauxite nor bauxitic clay in either of the pits. No other outcrops of the ore were found on the farm. The following sections show the results of the test pits:

Section of O. D. Gray test pit No. 1

	Feet
Soil	1.0
Wilcox	
Clay, reddish-yellow, and a little sand	7.0
Clay, yellowish-gray, and sand	6.0

Section of O. D. Gray test pit No. 2

Wilcox		Feet
5.	Clay and soil	1.5
4.	Clay, yellowish-gray	4.0
3.	Clay, lignitic, and sand	1.5
2.	Clay, yellowish-gray, and a little sand	2.5
1.	Sand, yellow and gray, micaceous, and clay	0.8

J. L. Luther Property

The J. L. Luther property, containing 105 acres, is in the SE. ¼ Sec. 22, T. 9 S., R. 1 E. There are a number of boulders of hard, red, pisolitic ore near the top of the high hill 900 feet northwest of the house. Small fragments of yellowish-gray ore are found also on the surface in the vicinity of the house and barn. In the search for the ore two pits were sunk on the farm. Pit No. 1 is on the top of this hill above the outcropping ore. Test pit No. 2 is near the barn which is south of the house.

Section of J. L. Luther test pit No. 1

Wilcox		Feet
7.	Clay, reddish-yellow, and sand	6.2
6.	Sand, yellowish-red	9.1
5.	Bauxitic clay, gray	2.5
4.	Sand, light yellow, coarse-grained	4.1
3.	Sand, light yellow, and clay	2.4
2.	Bauxitic clay, gray	3.2
1.	Sand, yellowish-gray	2.7

Section of J. L. Luther test pit No. 2

Wilcox		Feet
2.	Sand, yellow and gray	3.8
1.	Sand and clay, reddish-yellow	4.2

Gray bauxitic clay was encountered in test pit No. 1 at a depth of 15.3 feet. It is 2.5 feet thick and is underlain by 6.5 feet of sand and a little clay, and a second layer of gray bauxitic clay having a thickness of 3.2 feet. The remaining 2.7 feet of the pit wall consists of yellowish-gray sand.

As there are no other bauxite outcrops on the farm, it is very doubtful if there are any deposits of importance. The bauxitic clay found in pit No. 1 has too small an area and too great an overburden to be of commercial importance.

T. A. Montgomery Property

(Map 7)

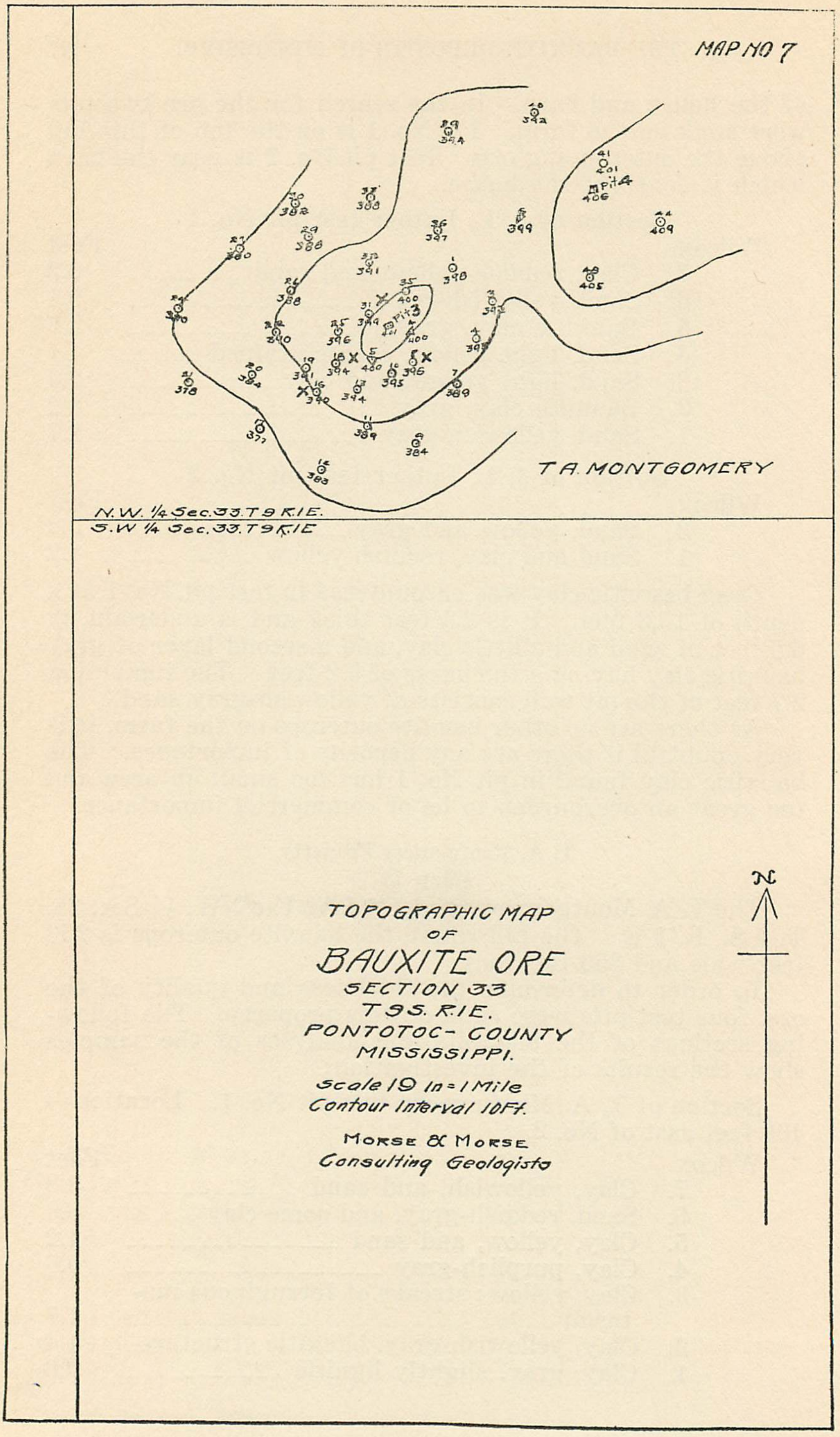
The T. A. Montgomery property is in the NW. ¼ Sec. 33, T. 9 S., R. 1 E. The hill where the bauxite outcrops is 250 feet wide and 350 feet long.

In order to determine the thickness and quality of the ore, four test pits were sunk on this property. The following sections of the test pits and analyses of the samples show the results of the investigation:

Section of T. A. Montgomery test pit No. 1. Location—400 feet east of No. 2.

Wilcox		Feet
7.	Clay, yellowish, and sand	3.8
6.	Sand, reddish-gray, and some clay	6.0
5.	Clay, yellow, and sand	1.2
4.	Clay, purplish-gray	0.5
3.	Clay, yellow; streaks of ferruginous material	1.7
2.	Clay, yellowish-gray, bauxitic structure	1.4
1.	Clay, gray, slightly lignitic	0.6

VII



TOPOGRAPHIC MAP
OF
BAUXITE ORE
SECTION 33
T9S. R1E.
PONTOTOC- COUNTY
MISSISSIPPI.

Scale 19 In = 1 Mile
Contour Interval 10 Ft.

MORSE & MORSE
Consulting Geologists

Section of T. A. Montgomery test pit No. 2. Location—700 feet south of house.

Wilcox	Feet
3. Clay, reddish, and sand	3.2
2. Clay, reddish-yellow	2.5
1. Clay, yellowish-gray, jointed	3.5

Section of T. A. Montgomery test pit No. 3

	Feet
5. Soil	3.0
Wilcox	
4. Bauxite, soft, ferruginous. Sample No. 56	3.3
3. Clay, yellow; streaks of ferruginous material	1.5
2. Clay, yellow	2.3
1. Clay, reddish-yellow	2.0

Analysis of bauxite from T. A. Montgomery test pit No. 3

	S-56
Aluminum oxide (Al_2O_3)	29.75
Ferric oxide (Fe_2O_3)	33.39
Silicon dioxide (SiO_2)	14.70
Titanium dioxide (TiO_2)	1.40
Loss on ignition	15.80
Non-volatile with HF	0.65
Moisture	3.12
	98.81

Section of T. A. Montgomery test pit No. 4

Wilcox	Feet
3. Clay, yellow, and sand	5.9
2. Sand, yellow, coarse-grained, and a little clay	3.1
1. Clay, gray, and a little sand	2.4

Test pit No. 3 is on the highest part of the hill and has an elevation of 401 feet. The top of the 3.3 feet of ferruginous bauxite has an elevation of 398 feet. The ore outcrops around the pit at elevations of 390, 394, 396, and 399 feet. The ore in the outcrop is hard, red, and pisolitic and has as high a content of Ferric oxide as does the ore in the pit.

Map 7 and Table 8 show a small hill of bauxite at an elevation of 398 feet and ore containing about 30 per cent Al_2O_3. The hill is estimated to contain:

Ore, Al_2O_3	30 per cent	1,210 tons

Because of the low content of Al_2O_3, the high content of impurities, and its small area, this deposit is of no importance.

TABLE VIII.—MONTGOMERY, ANDERSON, AND TUTOR

PIT		SECTION				ANALYSIS					
Name—	Elevation Feet	Description	Beds Other Feet	Beds Bauxite Feet	Sample No.	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	Loss on ignition	Moisture
T. A. Montgomeery No. 3	401	Over burden	3.0	--	--	----	----	----	---	----	---
		Bauxite	--	3.3	56	29.75	33.39	14.70	1.40	15.80	3.12
		Clay	5.8	--	--	----	----	----	---	----	---
E. E. Anderson No. 1	444	Over burden	8.7	--	--	----	----	----	---	----	---
		Bauxite	--	2.5	65	28.54	31.56	15.20	1.60	15.55	5.95
		Clay	9.2	--	--	----	----	----	---	----	---
J. W. Tutor No. 2	445	Over burden	4.1	--	--	----	----	----	---	----	---
		Bauxite, red	--	4.7	66	36.63	26.27	14.18	1.60	14.83	3.25
		Clay	0.3	--	--	----	----	----	---	----	---
		Bauxite	--	2.9	67	41.46	13.42	21.92	1.52	16.30	4.20
		Clay and sand	3.9	--	--	----	----	----	---	----	---
J. W. Tutor No. 3	447	Over burden	3.1	--	--	----	----	----	---	----	---
		Clay, bauxitic	--	3.7	68	35.65	9.07	31.00	1.68	14.05	7.18
		Bauxite, soft	--	3.3	69	30.29	23.91	18.28	1.60	16.45	4.10
		Bauxite, soft	--	5.8	70	37.04	13.00	25.94	1.76	16.30	5.50
		Clay	1.7	--	--	----	----	----	---	----	---
J. W. Tutor No. 5	432	Over burden	2.5	--	--	----	----	----	---	----	---
		Bauxite	--	1.9	79	32.96	21.38	21.24	1.76	16.15	3.77
		Clay, bauxitic	1.0	--	--	----	----	----	---	----	---
		Clay									

Mrs. N. A. Short Property

The property of Mrs. N. A. Short, containing 150 acres, consists of 20 acres in the SW. ¼ Sec. 32, and 30 acres in the SE¼ of the same Sec., T. 8 S., R. 1 E. and 80 acres in the NE. ¼ Sec. 5 and 20 acres in the NW. ¼ of the same Sec., T. 9 S., R. 1 E.

Test pit No. 1 is 300 feet south of the Lafayette Springs road and one-half mile west of T. A. Montgomery's house. The outcropping ore is found on one small hill only, where fragments and boulders of hard, reddish-brown, pisolitic bauxite are on the top of the hill as well as on the sides.

Test pit No. 1 is on top of the hill and has 4.7 feet of reddish-yellow clay and sand as overburden. The layer of soft, yellowish bauxite varies in thickness in the pit from 1.5 to 3.4 feet. The area of the hill is so small and the ore is so poor that the material at the pit is worthless. The following section and analysis show the geologic relations and the character of the ore:

Section of Mrs. N. A. Short test pit No. 1

Wilcox	Feet
4. Clay, reddish-yellow, and sand	4.7
3. Bauxite, soft, yellowish, 1.5-3.4 in thickness. Sample No. 57 of 3.4 bed	1.5
2. Clay, yellow and gray; bauxitic in upper part	5.5
1. Clay, yellowish-gray; slight pisolitic structure in part of it	3.5

Analysis of bauxite from Mrs. N. A. Short test pit No. 1

	S-57
Aluminum oxide (Al_2O_3)	27.58
Ferric oxide (Fe_2O_3)	21.56
Silicon dioxide (SiO_2)	26.38
Titanium dioxide (TiO_2)	1.76
Loss on ignition	15.83
Non-volatile with HF	1.56
Moisture	4.90
	99.57

B. F. Anderson Property

The B. F. Anderson property, containing 82 acres, is in the S. ½ SW. ¼ Sec. 11, T. 10 S., R. 1 E. Some boulders of hard, reddish-brown, pisolitic ore outcrop on the hill east of the barn, also on the hill across the small ravine south of the barn. Most of the outcrop consists of small fragments of ore that are found only by careful search.

Three pits were sunk on this farm to determine the thickness and area of the ore beds and the quality of the ore. Test pit No. 1 is 150 feet east of the barn and No. 2 is on the side of the hill across the small ravine south of No. 1. Test pit No. 3 is one-fourth mile northwest of the house on the side of the hill above the outcrop of ore. The following sections and analysis show the results of the investigation:

Section of B. F. Anderson test pit No. 1

Wilcox	Feet
5. Sand, yellow, and a small amount of clay	1.5
4. Clay and sand, reddish-yellow	6.0
3. Clay, gray and yellow, plastic, jointed	6.0
2. Bauxitic clay, yellowish	2.0
1. Bauxite, red, ferruginous. 3.0-3.5	3.0

Section of B. F. Anderson test pit No. 2

Wilcox	Feet
8. Sand and clay, red	3.7
7. Sand, reddish	7.5
6. Clay and sand, yellowish-gray	4.5
5. Sand, yellow	6.0
4. Sand and clay, reddish-yellow	2.0
3. Clay, dark gray, plastic	2.2
2. Bauxitic clay, soft, gray. Sample No. 47	3.4
1. Clay and bauxitic clay, interbedded, dark gray	1.1

Analysis of bauxitic clay from B. F. Anderson test pit No. 2

	S-47
Aluminum oxide (Al_2O_3)	30.18
Ferric oxide (Fe_2O_3)	4.54
Silicon dioxide (SiO_2)	44.62
Titanium dioxide (TiO_2)	1.28
Loss on ignition	12.15
Non-volatile with HF	0.40
Moisture	6.77
	99.94

Section of B. F. Anderson test pit No. 3

Wilcox	Feet
6. Soil, yellow clay and sand	3.8
5. Bauxitic clay and streaks of hard, red bauxite; streak of ferruginous material at bottom	1.3
4. Bauxitic clay, soft, yellowish-gray. Sample No. 82	1.3

3. Clay, slightly pisolitic, sand, and streaks of iron	1.0
2. Clay, yellow, and some sand	2.6
1. Clay, dark gray, lignitic, and micaceous sand	4.8

Analysis of bauxitic clay from B. F. Anderson test pit No. 3

	S-82
Aluminum oxide (Al_2O_3)	31.91
Ferric oxide (Fe_2O_3)	2.43
Silicon dioxide (SiO_2)	38.34
Titanium dioxide (TiO_2)	1.76
Loss on ignition	11.00
Non-volatile with HF	11.82
Moisture	3.05
	100.31

Note: The high non-volatile residue obtained by treating the "silica" causes us to suspect this sample to contain more or less clay which is not decomposed by the tri-acid treatment.—Hand.

D. H. Tutor Property

The D. H. Tutor property, containing 160 acres, is in the SE. ¼ Sec. 4, T. 10 S., R. 1 E. The bauxite outcrops on but one hill on the farm, and only on the highest part of this hill. Apparently, the ore has been let down from a higher elevation as the result of erosion. Test pit No. 1 is near the center of the hill and failed to penetrate any bauxite. Test pit No. 2 is 155 feet west of No. 1 on the west end of the hill. At a depth of 3.6 feet a layer of bauxitic clay 3.6 feet thick was encountered. In this pit, the bauxitic clay is resting on 0.9 foot of lignitic clay and red sand. In no other pit was bauxite or bauxitic clay found immediately adjacent to lignitic material. The following sections show the formations of the test pits:

Section of D. H. Tutor test pit No. 1

Wilcox	Feet
3. Clay, reddish, sand, and soil	1.6
2. Clay and sand, yellow	3.0
1. Sand, gray	1.9

Section of D. H. Tutor test pit No. 2

Wilcox	Feet
4. Clay and soil, reddish-yellow	2.0
3. Clay, gray	1.6
2. Bauxitic clay, soft, gray. Sample No. 80	3.6
1. Lignitic clay and red sand	0.9

Analysis of bauxitic clay from D. H. Tutor test pit No. 2

	S-80
Aluminum oxide (Al_2O_3)	39.78
Ferric oxide (Fe_2O_3)	1.00
Silicon dioxide (SiO_2)	38.34
Titanium dioxide (TiO_2)	1.74
Loss on ignition	14.12
Non-volatile with HF	2.66
Moisture	3.17
	100.81

John Wiley Tutor Property

(Map 9)

The John Wiley Tutor property, containing 177 acres, is in the S. ½ NW. ¼ and the SW. ¼ Sec. 16, T. 10 S., R. 1 E. However, the known deposits of bauxite are found only in the S. ½ NW. ¼ Sec. 16. The ore is near the top of an elliptical hill, which is 800 feet long and 400 feet wide and 50 feet high. The red, pisolitic ore outcrops around test pits Nos. 2, 4, and 5.

The prospecting work to determine the amount and quality of the ore consisted of the sinking of seven test pits. The results of the investigation are given in the following sections of test pits and analyses of samples:

Section of John Wiley Tutor test pit No. 1

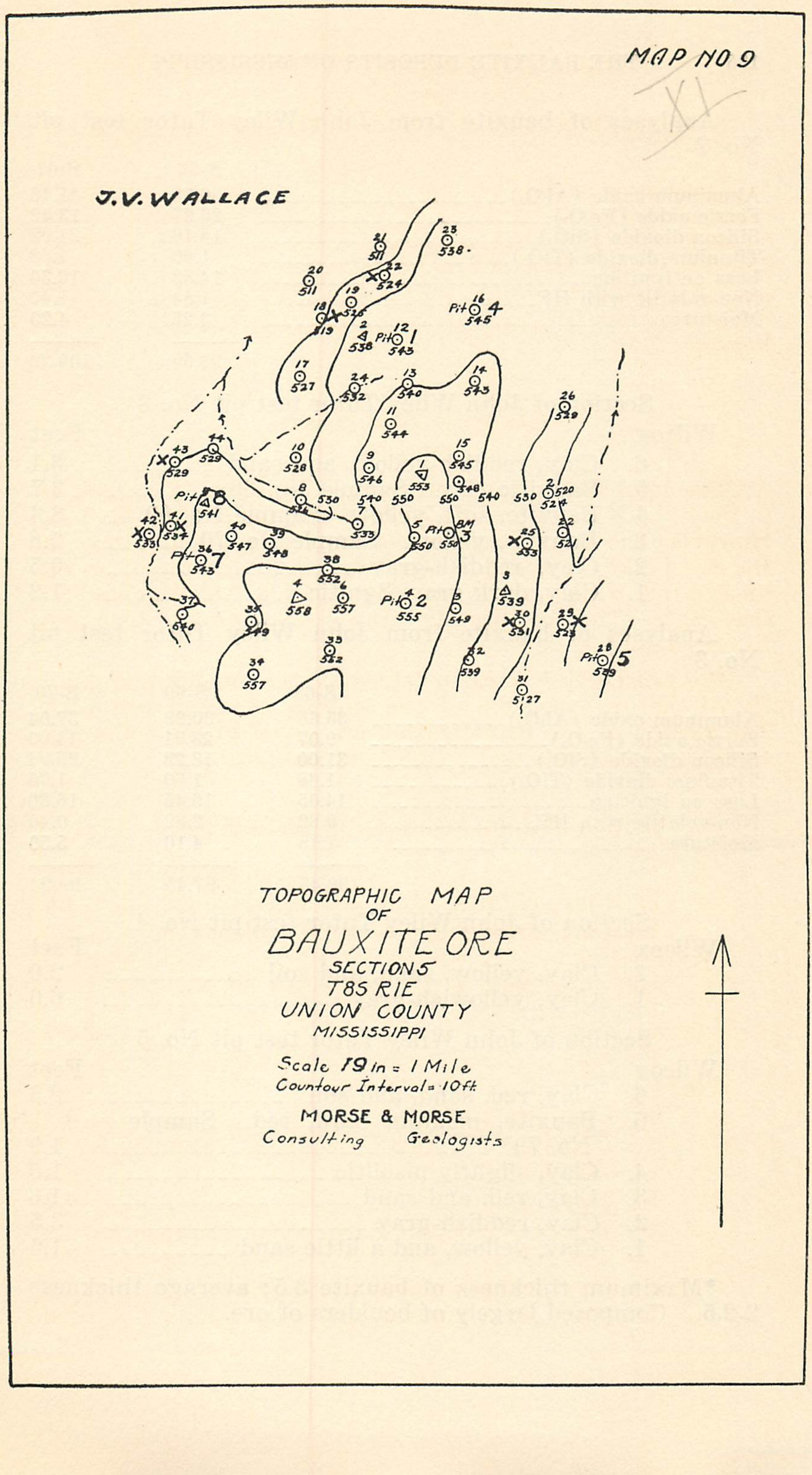
	Feet
2. Clay, reddish, sand, and soil	1.6
1. Clay, gray, and streaks of yellow sand	6.0

Section of John Wiley Tutor test pit No. 2

Wilcox	Feet
7. Soil	1.0
Wilcox	
6. Clay, red, and sand	3.1
5. Bauxite, hard, red, ferruginous. Sample No. 66	4.7
4. Clay, yellow	0.3
3. Bauxite, medium hard, red. Sample No. 67	2.9
2. Clay, yellowish-gray, some sand	1.9
1. Clay, gray, gummy, and some sand	2.0

MAP NO 9

XI



TOPOGRAPHIC MAP
OF
BAUXITE ORE
SECTION 5
T8S R1E
UNION COUNTY
MISSISSIPPI

Scale 19 in = 1 Mile
Countour Interval = 10 ft.

MORSE & MORSE
Consulting Geologists

Analyses of bauxite from John Wiley Tutor test pit No. 2

	S-66	S-67
Aluminum oxide (Al_2O_3)	36.63	41.46
Ferric oxide (Fe_2O_3)	26.27	13.42
Silicon dioxide (SiO_2)	14.18	21.92
Titanium dioxide (TiO_2)	1.60	1.52
Loss on ignition	14.83	16.30
Non-volatile with HF	1.84	1.40
Moisture	3.25	4.20
	98.60	100.22

Section of John Wiley Tutor test pit No. 3

Wilcox	Feet
6. Clay, reddish-yellow, and sand	3.1
5. Bauxitic clay. Sample No. 68	3.7
4. Bauxite, soft, yellow. Sample No. 69	3.3
3. Bauxite, yellow. Sample No. 70	5.8
2. Clay, reddish-gray	0.5
1. Clay, dark gray, lignitic	1.2

Analyses of bauxite from John Wiley Tutor test pit No. 3

	S-68	S-69	S-70
Aluminum oxide (Al_2O_3)	35.65	30.29	37.04
Ferric oxide (Fe_2O_3)	9.07	23.91	13.00
Silicon dioxide (SiO_2)	31.00	18.28	25.94
Titanium dioxide (TiO_2)	1.68	1.60	1.76
Loss on ignition	14.05	16.45	16.30
Non-volatile with HF	0.82	2.82	0.40
Moisture	7.18	4.10	5.50
	99.45	97.45	99.94

Section of John Wiley Tutor test pit No. 4

Wilcox	Feet
2. Clay, yellow, sand, and soil	2.0
1. Clay, yellowish-gray	6.0

Section of John Wiley Tutor test pit No. 5

Wilcox	Feet
6. Clay, red, sand, and soil	2.5
5. Bauxite, medium hard, red. Sample No. 79*	1.9
4. Clay, slightly pisolitic	1.0
3. Clay, red, and sand	1.6
2. Clay, reddish-gray	3.5
1. Clay, yellow, and a little sand	1.5

*Maximum thickness of bauxite 3.5; average thickness 2-2.5. Composed largely of boulders of ore.

Analysis of bauxite from John Wiley Tutor test pit No. 5

	S-79
Aluminum oxide (Al_2O_3)	32.96
Ferric oxide (Fe_2O_3)	21.38
Silicon dioxide (SiO_2)	21.24
Titanium dioxide (TiO_2)	1.76
Loss on ignition	16.15
Non-volatile with HF	2.28
Moisture	3.77
	99.54

Section of John Wiley Tutor test pit No. 6

	Feet
Wilcox	
3. Clay, reddish-yellow, and sand	2.2
2. Sand, yellow and gray, micaceous, and clay	5.2
1. Sand, dark gray, micaceous, and clay	3.5

Section of John Wiley Tutor test pit No. 7

	Feet
6. Soil	1.0
Wilcox	
5. Clay, reddish-yellow, and micaceous sand	1.3
4. Sand, reddish-gray, micaceous, and clay	3.0
3. Sand, yellow micaceous, and clay	1.5
2. Sand, gray, micaceous, and clay	2.1
1. Clay, dark gray, lignitic, and micaceous sand	1.7

The top of the bauxite in the John Wiley Tutor test pit No. 2 has an elevation of 441 feet (B. M. assumed). The top layer of hard, red bauxite is 4.7 feet thick and is underlain by 0.3 foot of yellow clay and a second layer of bauxite having a thickness of 2.9 feet. The remaining 4 feet of the pit wall is made up of yellowish-gray clay and gray, gummy clay and some sand. The top of the bauxite in test pit No. 3 has an elevation of 440 feet, although the ore is overlain by 3.7 feet of bauxitic clay. The 9 feet of bauxite is underlain by 0.5 foot of reddish-gray clay and 1.2 feet of dark gray, lignitic clay. The top of the bauxite in test pit No. 5 has an elevation of 430 feet. The layer of ore has a thickness of 1.9 feet and is underlain by one foot of pisolitic clay and 5 feet of red and reddish-gray clay and sand. The bauxite in this pit has a maximum thickness of 3.5 feet, an average thickness of 2.0 to 2.5 feet, and is composed largely of boulders of ore.

Map 9 and Table 8 show the top of the bauxite to range from 429 to 444 feet in elevation and the ore to range from 30 to 41 per cent in Al_2O_3.

Tonnage of John Wiley Tutor property

Ore, Al_2O_3	30 per cent	8,500 tons
Ore, Al_2O_3	36 per cent	34,000 tons
Ore, Al_2O_3	41 per cent	8,500 tons
Total		51,000 tons

S. L. Tutor Property

The S. L. Tutor property, containing 53 1-3 acres, consists of the east 1-3 of the SE. ¼ Sec. 17, T. 10 S., R. 1 E. This property joins the John Wiley Tutor farm on the west. The only outcrop on the farm consists of several large boulders of hard, reddish-brown, pisolitic ore, 55 feet southeast of the house. The boulders of bauxite are a foot lower than the mouth of the pit, which is only a few feet from them. Below the 0.8 foot of soil in the pit wall is a layer of reddish-yellow, bauxitic clay. It is very doubtful if there are any deposits of importance on this property, because there are no good surface indications of ore.

Section of S. L. Tutor test pit No. 1

			Feet
	4.	Soil	0.8
Wilcox			
	3.	Bauxitic clay, reddish-yellow	1.3
	2.	Clay, yellow	2.1
	1.	Clay, yellowish-gray	3.8

Union County

Topographic and Geologic Location

Union County, adjoining Pontotoc County on the north, is in the north central part of the state. Like Pontotoc County it is in parts of four physiographic regions; namely, the Black Prairie belt, the Pontotoc Ridge, the Flatwoods, and the North Central Plateau. The four terranes, characteristic respectively of these physiographic regions, are the Selma chalk and the Ripley of the (Upper) Cretaceous, and the Midway and the Wilcox series of the lower Eocene.

In the extreme eastern part, the outcrop of Selma chalk forms a belt approximately three miles wide, extending from the north to the south side of the county. Just west of the Selma is the belt of Ripley which has increased in width from nine miles in Pontotoc to thirteen miles in this county. The Midway series outcrops in a belt twelve to fifteen miles wide that covers nearly the entire western half of the county. In the extreme southwestern part the Wilcox series forms a belt three to four miles wide.

Stratigraphy

The stratigraphy of Union County is very similar to that of Pontotoc County, which has already been discussed on pp. 89, 90 and need not be repeated.

The Ore

The bauxite deposits of Union County are confined to the extreme southwestern corner, Townships 7 and 8 South. They are three to five miles north of the large ones at Smoky Top. The known deposits have a very limited area and, owing to the poor quality of the ore and the distance from the railroad, are of little importance. However, the presence of a bauxitic clay and a clay having many of the properties of Fuller's earth offers possibilities of development in connection with the bauxite at Smoky Top. There are other extensive bodies of high-grade clay in this region. Many of these deposits, however, are found only when test pits are sunk. Little is known, therefore, about their extent.

The bauxite in the county is in the basal Wilcox (Eocene), probably in the Ackerman formation near its contact with the Porters Creek clay of the Midway series. It is in beds which extend over small areas and which vary in thickness from one foot to seven feet. The pisolitic or oolitic, or a mixture of these two varieties, is the type of ore found in the county. The deposits are interstratified with impure clays, kaolin, bauxitic clays, and Fuller's earth.

The following properties in Union County have outcrops or known deposits of bauxite and bauxitic clay:

J. V. Wallace—200 acres, Sec. 5, T. 8 S., R. 1 E.
T. D. Messer—60 acres, Sec. 8, T. 8 S., R. 1 E.
L. B. Busby—NW. ¼ and SW. ¼ Sec. 33, T. 7 S., R. 1 E.
L. W. Robbins—97 acres, Sec. 10, T. 8 S., R. 1 E.
Jack Williams—Sec. --, T. 8 S., R. 1 E.
Tom Hudson—160 acres, Sec. 16, T. 8 S., R. 1 E.
O. D. Gray—200 acres, Secs. 4 and 5, T. 8 S., R. 1 E.

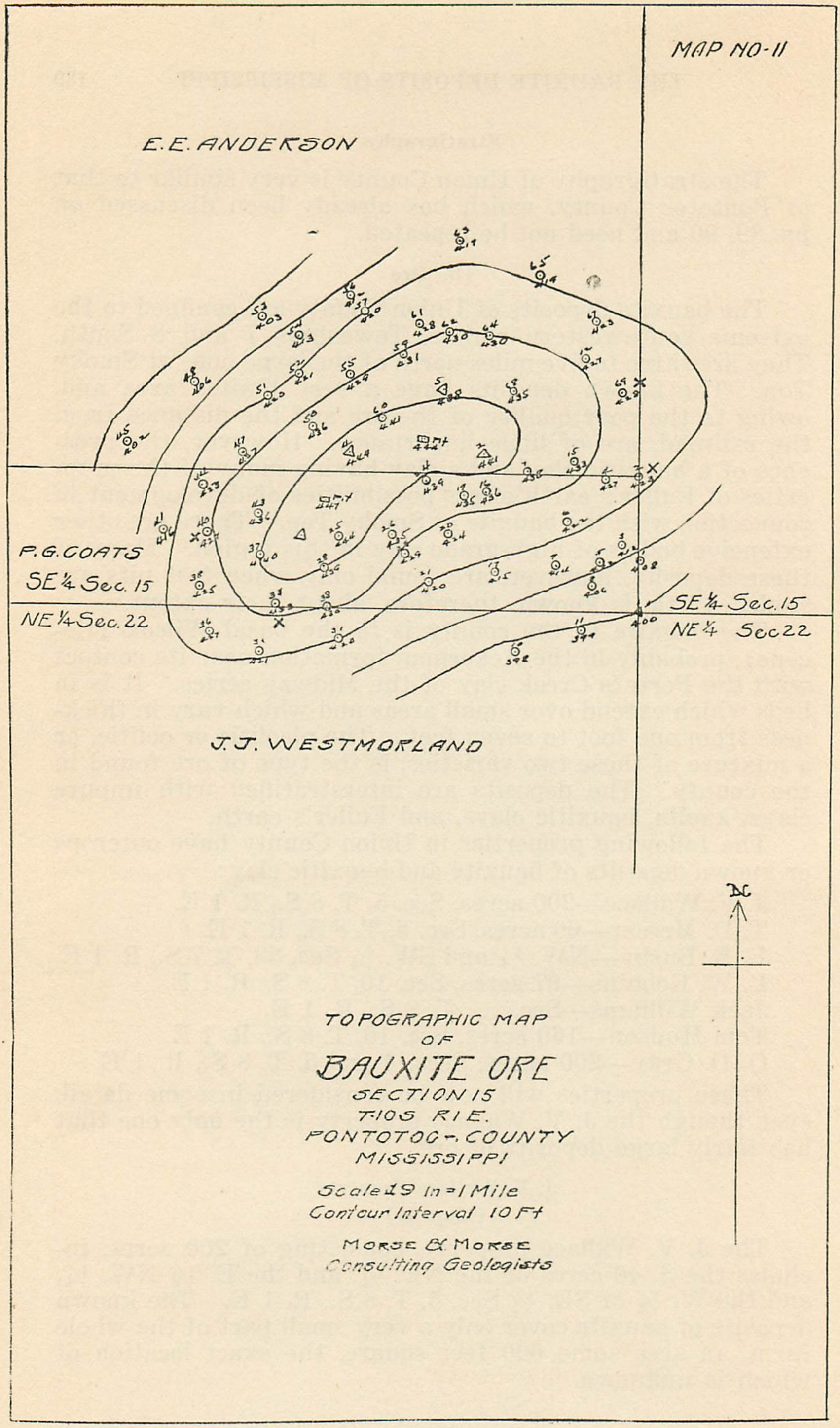
These properties will now be considered in some detail, even though the J. V. Wallace property is the only one that has fairly large deposits of ore.

J. V. Wallace Property

(Map 11)

The J. V. Wallace property, consisting of 200 acres, includes the S. 40 acres of the NE. ¼, and the E. ½ NW. ¼, and the W. ½ of SE. ¼ Sec. 5, T. 8 S., R. 1 E. The known deposits of bauxite cover only a very small part of the whole farm, an area some 600 feet square, the exact location of which is unknown.

VIII


MAP NO-11
E.E. ANDERSON
P.G. COATS
SE¼ Sec. 15
NE¼ Sec. 22
SE¼ Sec. 15
NE¼ Sec 22
J.J. WESTMORLAND
N
TOPOGRAPHIC MAP
OF
BAUXITE ORE
SECTION 15
T-10S R1E.
PONTOTOC - COUNTY
MISSISSIPPI
Scale 19 In = 1 Mile
Contour Interval 10 Ft
MORSE & MORSE
Consulting Geologists

In order to determine the extent of the ore beds and quality of the ore, eight test pits were sunk on the property. The results of the investigation are given in the following sections of test pits and analyses of samples from the pits:

Section of J. V. Wallace test pit No. 1

Wilcox		Feet
6.	Clay and sand, yellow	4.0
5.	Sand, yellowish-red	7.7
4.	Clay, gray and yellow	1.5
3.	Bauxitic clay, reddish-yellow. Sample No. 52	2.6
2.	Bauxitic clay, bluish-gray. Sample No. 52 includes beds No. 2 and No. 3	3.2
1.	Clay, plastic, bluish-gray	4.5

Analysis of bauxitic clay from J. V. Wallace test pit No. 1

	S-52
Aluminum oxide (Al_2O_3)	30.12
Ferric oxide (Fe_2O_3)	16.86
Silicon dioxide (SiO_2)	30.58
Titanium dioxide (TiO_2)	1.36
Loss on ignition	15.82
Non-volatile with HF	0.44
Moisture	4.77
	99.95

Section of J. V. Wallace test pit No. 2

Wilcox		Feet
3.	Clay and sand, yellow	3.8
2.	Sand, gray and yellow, micaceous, and a small amount of clay	19.7
1.	Clay, dark gray, and micaceous sand	5.5

Section of J. V. Wallace test pit No. 3

Wilcox		Feet
7.	Soil, reddish-yellow, clay, and sand	6.0
6.	Sand and clay, gray	8.5
5.	Sand, reddish-gray; some yellow sand at bottom	3.5
4.	Clay, yellow, slightly pisolitic; red in places	0.8
3.	Bauxite, hard, red, ferruginous. Sample No. 93	4.5
2.	Bauxite, medium hard, olive drab. Sample No. 94	3.5
1.	Clay, blue, plastic	1.1

Analyses of bauxite from J. V. Wallace test pit No. 3

	S-93	S-94
Aluminum oxide (Al_2O_3)	41.07	43.67
Ferric oxide (Fe_2O_3)	25.49	15.13
Silicon dioxide (SiO_2)	10.06	15.66
Titanium dioxide (TiO_2)	1.84	2.00
Loss on ignition	18.80	21.40
Non-volatile with HF	0.92	0.64
Moisture	3.43	1.60
	101.61	100.10

Section of J. V. Wallace test pit No. 4

Wilcox	Feet
3. Clay and sand, yellowish-red	6.4
2. Sand, yellowish-gray, coarse-grained; and thin streaks of dark gray clay	5.0
1. Sand, yellowish-gray, coarse-grained	10.5

Section of J. V. Wallace test pit No. 5

	Feet
6. Soil	1.7
Wilcox	
5. Sand, yellowish-gray	8.0
4. Bauxitic clay, yellow. Sample No. 71	1.4
3. Clay, yellowish-gray, and a little sand	2.8
2. Bauxitic clay; upper 2 feet yellow; lower 2 feet gray. Sample No. 71 includes No. 2 and No. 4 beds	4.0
1. Clay, bluish gray, and sand	2.4

Analysis of bauxitic clay from J. V. Wallace test pit No. 5

	S-71
Aluminum oxide (Al_2O_3)	34.43
Ferric oxide (Fe_2O_3)	8.81
Silicon dioxide (SiO_2)	29.86
Titanium dioxide (TiO_2)	1.76
Loss on ignition	14.53
Non-volatile with HF	0.58
Moisture	9.80
	99.77

Section of J. V. Wallace test pit No. 6

Wilcox	Feet
Sand, gray and yellow	9.0

Section of J. V. Wallace test pit No. 7

Wilcox	Feet
7. Clay, reddish-yellow, and sand	5.3
6. Sand, bluish-gray, and an occasional concretion of iron	3.8
5. Bauxitic clay, soft yellow. Sample No. 72	1.2

4.	Bauxite, hard, red. Sample No. 73	2.4
3.	Bauxite, soft, yellowish-green. Sample No. 74	2.5
2.	Bauxitic clay, yellowish-gray	0.9
1.	Clay, bluish-gray; the upper part has some concretions of iron	1.2

Analyses of bauxite from J. V. Wallace test pit No. 7

	S-72	S-73	S-74
Aluminum oxide (Al_2O_3)	25.23	26.86	35.98
Ferric oxide (Fe_2O_3)	17.79	38.56	14.46
Silicon dioxide (SiO_2)	32.54	11.58	26.92
Titanium dioxide (TiO_2)	1.52	1.52	1.76
Loss on ignition	12.44	15.45	15.55
Non-volatile with HF	6.00	1.06	0.58
Moisture	4.01	3.84	5.12
	99.53	98.87	100.37

Section of J. V. Wallace test pit No. 8

Wilcox		Feet
5.	Clay and sand	3.6
4.	Clay, soft, yellow, and irony material	1.0
3.	Bauxite; lower foot soft, yellow; upper 2.6 feet medium hard, red bauxite. Sample No. 76	3.6
2.	Bauxitic clay, yellowish-gray	1.2
1.	Clay, bluish-gray; upper part has some iron concretions	1.7

Analysis of bauxite from J. V. Wallace test pit No. 8

	S-76
Aluminum oxide (Al_2O_3)	30.35
Ferric oxide (Fe_2O_3)	32.65
Silicon dioxide (SiO_2)	15.02
Titanium dioxide (TiO_2)	1.60
Loss on ignition	16.10
Non-volatile with HF	1.26
Moisture	2.95
	99.93

The top of the bauxite in the J. V. Wallace test pit No. 1 has an elevation of 530 feet (B. M. assumed). The ore outcrops below this pit at elevations of 527, 519, and 524 feet on the west side of the hill (Map 11). The ore in the outcrop is hard, red, pisolitic; and some of the blocks are several feet in diameter. No hard ore is found in the pit; the upper 2.6 feet is reddish-yellow, bauxitic clay and the lower 3.2 feet is bluish-gray in color. The bauxitic clay is underlain by 4.5 feet of bluish-gray, plastic clay. The top of the

TABLE IX.—BUSBY, WALLACE, AND MESSER

PIT Name—	PIT Elevation Feet	SECTION Description	SECTION Beds Other Feet	SECTION Beds Bauxite Feet	ANALYSIS Sample No.	ANALYSIS Al_2O_3	ANALYSIS Fe_2O_3	ANALYSIS SiO_2	ANALYSIS TiO_2	ANALYSIS Loss on ignition	ANALYSIS Moisture
L. B. Busby No. 1	454	Over burden	1.4	--	--	----	----	----	---	----	---
		Clay, bauxitic	2.0	--	--	----	----	----	---	----	---
		Bauxite	--	5.0	64	34.52	15.88	29.08	1.60	14.30	2.38
		Clay, bauxitic	1.0	--	--	----	----	----	---	----	---
		Clay	6.7	--	--	----	----	----	---	----	---
J. V. Wallace No. 1	543	Over burden	13.2	--	--	----	----	----	---	----	---
		Clay, bauxitic	--	5.8	52	30.12	16.86	30.58	1.36	15.82	4.77
		Clay	4.5	--	--	----	----	----	---	----	---
J. V. Wallace No. 3	550	Over burden	18.8	--	--	----	----	----	---	----	---
		Bauxite, hard	--	4.5	93	41.07	25.49	10.06	1.84	18.80	3.43
		Bauxite	--	3.5	94	43.67	15.13	15.66	2.00	21.40	1.60
		Clay	1.1	--	--	----	----	----	---	----	---
J. V. Wallace No. 5	539	Over burden	9.7	--	--	----	----	----	---	----	---
		Clay, bauxitic	--	1.4	71	----	----	----	---	----	---
		Clay	2.8	--	--	34.43	8.81	29.86	1.76	14.53	9.80
		Clay, bauxitic	--	4.0	71	----	----	----	---	----	---
		Clay and sand	2.4	--	--	----	----	----	---	----	---
J. V. Wallace No. 7	543	Over burden	9.1	--	--	----	----	----	---	----	---
		Bauxite, soft	--	1.2	72	25.23	17.79	32.54	1.52	12.44	4.01
		Bauxite, hard	--	2.4	73	26.86	38.56	11.58	1.52	15.45	3.84
		Bauxite, soft	--	2.5	74	35.98	14.46	26.92	1.76	15.55	5.12
		Clay, bauxitic	0.9	--	--	----	----	----	---	----	---
		Clay	1.2	--	--	----	----	----	---	----	---
J. V. Wallace No. 8	541	Over burden	3.6	--	--	----	----	----	---	----	---
		Bauxite, soft	--	1.0	75	9.37	41.19	31.18	1.44	12.95	1.97
		Bauxite	--	3.6	76	30.35	32.65	15.02	1.60	16.10	2.95
		Clay, bauxitic	1.2	--	--	----	----	----	---	----	---
		Clay	1.7	--	--	----	----	----	---	----	---
T. D. Messer No. 1	401	Over burden	8.9	--	--	----	----	----	---	----	---
		Bauxite	--	3.9	58	28.76	39.94	7.16	1.60	18.37	2.85
		Bauxite	--	2.9	59	36.60	14.44	27.26	1.76	15.80	2.35
		Clay, bauxitic	1.0	--	--	----	----	----	---	----	---
		Clay	0.6	--	--	----	----	----	---	----	---

ore in pit No. 3 has an elevation of 531 feet. The top of the ore in the outcrop east of the pit has elevations of 533 and 531 feet on the east side of the hill. Thus the bed of ore is practically horizontal for a distance of 500 feet. The top of the bauxitic clay in pit No. 5 has an elevation of 529 feet. The ore at the outcrop 75 feet northwest of the pit has an elevation of 528 feet. The remarkable thing about the outcrop is the fact that the ore is hard, reddish-brown, pisolitic bauxite, whereas the material in the test pit only 75 feet away is bauxitic clay. The top of the bauxite in test pit No. 7 has an elevation of 534 feet and of 537 feet in pit No. 8. The top of the ore in the outcrop west of the pits has the following elevations: 534, 533, and 529 feet. The elevation of the ore in the hill may be determined, therefore, from the loose blocks in the outcrop, provided the outcrop is carefully studied.

From Map 11 and Table 9, it is seen that the top of the bauxite has an elevation of 529 to 531 feet and that the composition varies from 30 to 44 per cent in Al_2O_3. A conservative estimate of the tonnage is:

Tonnage of J. V. Wallace property

Ore, Al_2O_3	30-34 per cent	39,733 tons
Ore, Al_2O_3	41-44 per cent	20,000 tons
Total		59,733 tons

T. D. Messer Property

(Map 12)

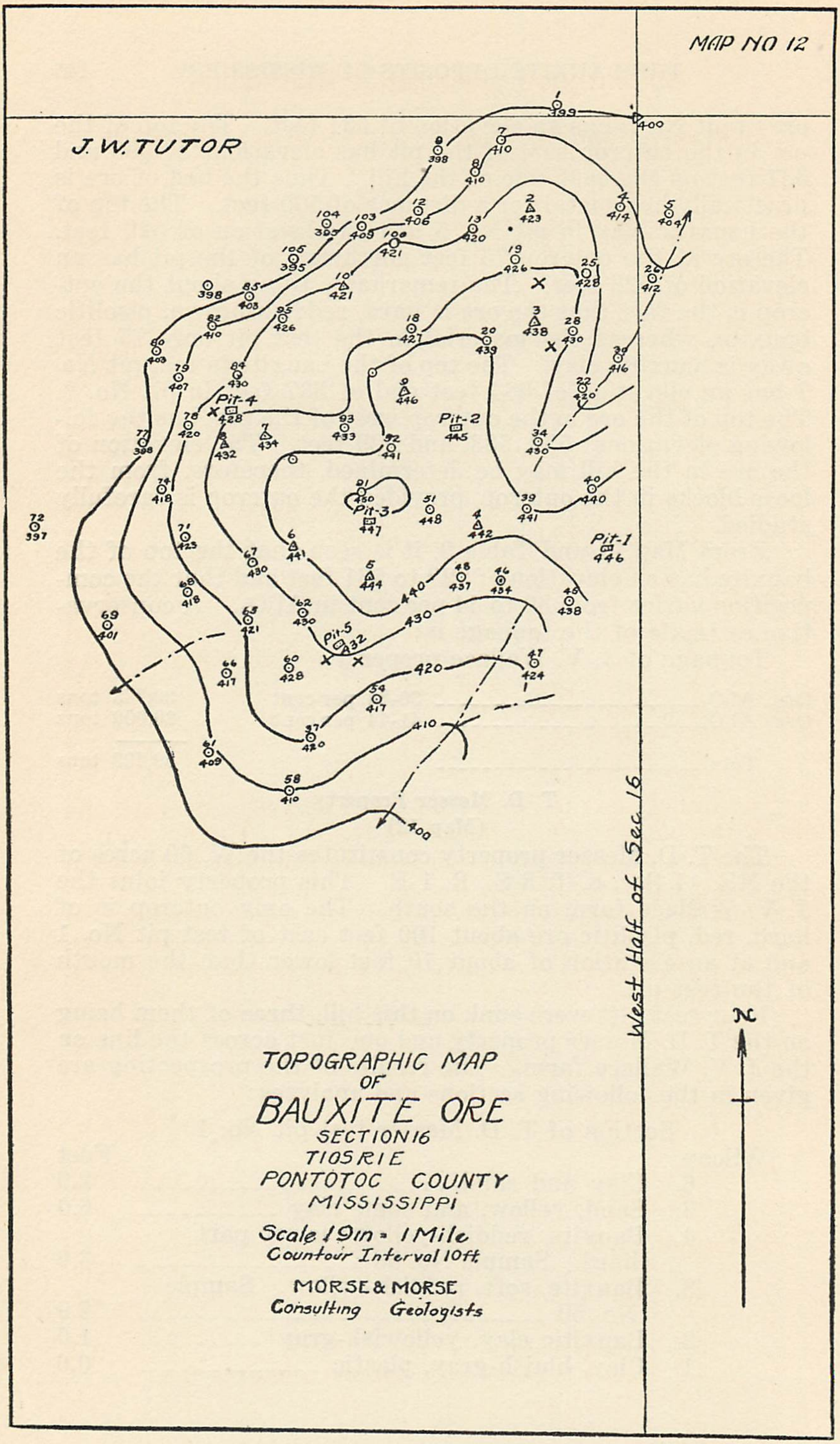
The T. D. Messer property constitutes the W. 60 acres of the NE. ¼ Sec. 8, T. 8 S., R. 1 E. This property joins the J. V. Wallace farm on the south. The only outcrop is of hard, red, pisolitic ore about 100 feet east of test pit No. 1 and at an elevation of about 10 feet lower than the mouth of the test pit.

Four test pits were sunk on this hill, three of them being on the T. D. Messer property and one just across the line on the J. V. Wallace farm. The results of the prospecting are given in the following sections and analyses:

Section of T. D. Messer test pit No. 1

Wilcox	Feet
6. Clay and sand	2.9
5. Sand, yellow, and some clay	6.0
4. Bauxite, reddish-yellow; lower part hard. Sample No. 58	3.9
3. Bauxite, soft, reddish-yellow. Sample No. 59	2.9
2. Bauxitic clay, yellowish-gray	1.0
1. Clay, bluish-gray, plastic	0.6

IX



TOPOGRAPHIC MAP
OF
BAUXITE ORE
SECTION 16
T10S R1E
PONTOTOC COUNTY
MISSISSIPPI
Scale 19in = 1 Mile
Countour Interval 10ft.
MORSE & MORSE
Consulting Geologists

Analyses of bauxite from T. D. Messer test pit No. 1

	S-58	S-59
Aluminum oxide (Al_2O_3)	28.76	36.60
Ferric oxide (Fe_2O_3)	39.94	14.44
Silicon dioxide (SiO_2)	7.16	27.26
Titanium dioxide (TiO_2)	1.60	1.76
Loss on ignition	18.37	15.80
Non-volatile with HF	0.42	0.30
Moisture	2.85	2.35
	99.10	98.51

Section of T. D. Messer test pit No. 2

Wilcox	Feet
4. Clay, yellow, and sand	2.8
3. Clay, reddish-yellow	3.0
2. Clay, gray, and some yellow sand	7.0
1. Sand, fine-grained, yellow	1.5

Section of T. D. Messer test pit No. 3

Wilcox	Feet
6. Clay, yellowish, and sand	3.0
5. Clay, yellowish-gray, and a little sand	6.0
4. Sand, gray, and clay	2.2
3. Clay, gray	2.3
2. Sand, gray, and clay	7.2
1. Sand, yellow	0.9

The top of the ore in test pit No. 1 corresponds with the top of the bauxite 100 feet east of the pit. The 6.8 feet of ferruginous, pisolitic ore is underlain by one foot of bauxitic clay and a half-foot of bluish-gray, plastic clay.

From the elevation of 392 feet of the top of the bauxite in pit No. 1 and the position of the outcrop of the T. D. Messer tract (Map 12), and from chemical analyses (Table 9) the probable tonnage and the average composition is:

Ore, Al_2O_3	**32 per cent**	**3,672 tons**

L. B. Busby Property

(Map 10)

The L. B. Busby property is in the NW. ¼ and SW. ¼ Sec. 33, T. 7 S., R. 1 E.

One pit was sunk on the top of the hill. The following section and analysis show the character of the ore:

Section of L. B. Busby test pit No. 1

	Feet
6. Soil	1.4
Wilcox	
5. Bauxitic clay	2.0
4. Bauxitic clay, soft, yellow. Sample No. 64	5.0

3.	Bauxitic clay; upper 0.1-0.3 ferruginous material	1.4
2.	Clay, dark, gray	1.7
1.	Clay, gray, jointed	5.0

Analysis of bauxite from L. B. Busby test pit No. 1

	S-64
Aluminum oxide (Al_2O_3)	34.52
Ferric oxide (Fe_2O_3)	15.88
Silicon dioxide (SiO_2)	29.08
Titanium dioxide (TiO_2)	1.60
Loss on ignition	14.30
Non-volatile with HF	0.42
Moisture	2.38
	98.18

The Busby pit is located on the highest part of the hill and has an elevation of 454 feet. The top of the 5 feet of soft, yellow, bauxitic clay has an elevation of 451 feet. Boulders of hard, brownish, pisolitic ore outcrop around the pit at elevations of 433, 441, and 447 feet. The 5 feet of gray clay in the bottom of the test pit has many of the properties of Fuller's earth. A test on cottonseed oil was made by the State Chemist with this material and with standard Fuller's earth. The oil was bleached almost as much with this clay as with the standard earth. As the bottom of the pit is still in the clay, there is no way of knowing what the thickness of the deposit is. With the Fuller's earth in sight at the present time the hill should contain 4,000 or 5,000 tons.

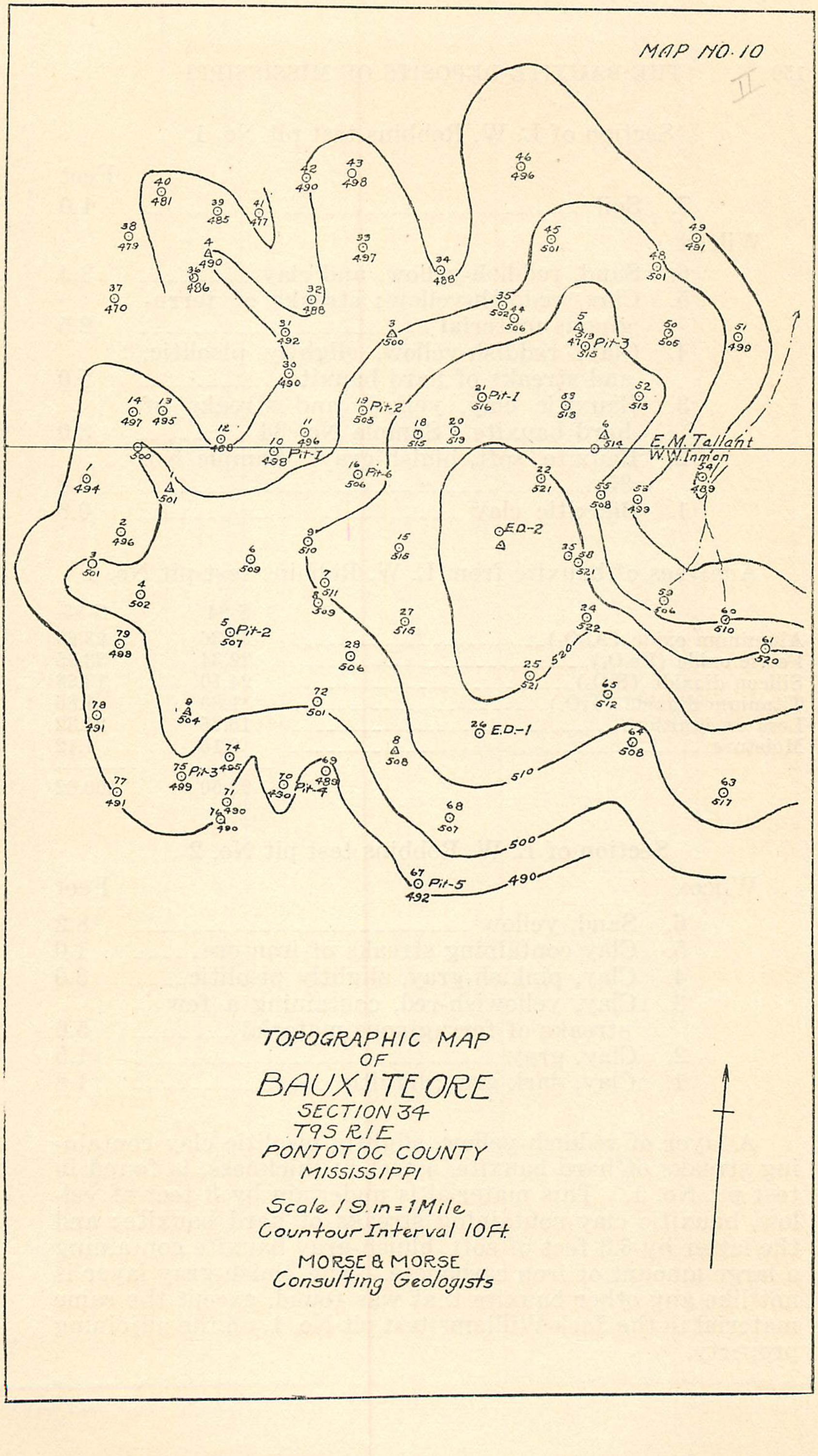
According to Map 10 and Table 9, the top of the bauxite on this tract lies at 450 feet and the ore contains 35 per cent Al_2O_3. The hill is estimated to have the following tonnage:

Ore, Al_2O_3	35 per cent	2,666 tons

L. W. Robbins Property

The L. W. Robbins property, containing 97 acres, consists of 37 acres in the N. ½ SW. ¼ Sec. 10, and 60 acres in the S. ½ SW. ¼ Sec. 10, T. 8 S., R. 1 E. The farm is one-fourth mile south of Pine Dale. There is a rather small outcrop of red, pisolitic bauxite on a large hill, the northern end of which is on the Jack Williams place. Two test pits were sunk on this farm to determine the extent and quality of the ore. Test pit No. 1 is near the old Pine Dale road, on the top of the hill. No. 2 is on the east end of the hill near a cultivated field. The results of the investigation are given in the following sections of pits and analyses of samples:

MAP NO. 10



TOPOGRAPHIC MAP
OF
BAUXITE ORE
SECTION 34
T9S R1E
PONTOTOC COUNTY
MISSISSIPPI

Scale 1.9 in = 1 Mile
Countour Interval 10 Ft.

MORSE & MORSE
Consulting Geologists

Section of L. W. Robbins test pit No. 1

		Feet
	7. Soil	1.0
Wilcox		
	6. Sand, reddish-yellow, and clay	3.4
	5. Clay, reddish-yellow; streaks of ferruginous material	2.5
	4. Clay, reddish-yellow, slightly pisolitic, and streaks of hard bauxite	5.0
	3. Bauxitic clay, yellow, and streaks of hard bauxite. Sample No. 84	3.0
	2. Bauxite, soft, bluish-gray. Sample No. 85	6.8
	1. Bauxitic clay	0.8

Analyses of bauxite from L. W. Robbins test pit No. 1

	S-84	S-85
Aluminum oxide (Al_2O_3)	32.36	23.25
Ferric oxide (Fe_2O_3)	22.34	33.95
Silicon dioxide (SiO_2)	24.10	18.58
Titanium dioxide (TiO_2)	1.80	1.80
Loss on ignition	16.75	21.32
Moisture	2.15	1.12
	99.50	100.02

Section of L. W. Robbins test pit No. 2

		Feet
Wilcox		
	6. Sand, yellow	8.2
	5. Clay containing streaks of iron ore	1.0
	4. Clay, pinkish-gray, slightly pisolitic	3.0
	3. Clay, yellowish-red, containing a few streaks of ferruginous material	5.0
	2. Clay, gray	1.5
	1. Clay, dark gray, lignitic	1.8

A layer of reddish-yellow, slightly pisolitic clay containing streaks of hard bauxite, 5 feet in thickness, is found in test pit No. 1. This material is underlain by 3 feet of yellow, bauxitic clay containing streaks of hard bauxite; and the latter by 6.8 feet of soft, bluish-gray bauxite containing a large amount of iron carbonate. The bluish-gray layer is not like any other bauxite that was found, except the same material in the Jack Williams test pit No. 1, on the adjoining property.

Jack Williams Property

Section of Jack Williams test pit No. 1

Wilcox		Feet
7.	Clay, reddish-yellow, and sand	5.0
6.	Clay, yellowish-gray, having a pisolitic structure	4.6
5.	Clay, yellow, slightly bauxitic, streaks of bauxite and iron	3.3
4.	Bauxitic clay, gray	1.3
3.	Clay, bluish-gray, and iron carbonate	1.0
2.	Bauxite, soft, bluish-gray, clayey. Sample No. 92	7.5
1.	Clay, bluish-gray, sticky	0.6

Analysis of bauxite from Jack Williams test pit No. 1

	S-92
Aluminum oxide (Al_2O_3)	28.07
Ferric oxide (Fe_2O_3)	25.81
Silicon dioxide (SiO_2)	20.44
Titanium dioxide (TiO_2)	1.52
Loss on ignition	20.83
Non-volatile with HF	0.60
Moisture	1.73
	99.00

Section of Jack Williams test pit No. 2

Wilcox		Feet
2.	Clay, reddish-yellow, and sand	4.5
1.	Sand, reddish-yellow, coarse-grained	9.5

Tom Hudson Property

The Tom Hudson property, consisting of 160 acres, is in the N. ½ SW. ¼ Sec. 16 and the S. ½ NW. ¼ Sec. 16, T. 8 S., R. 1 E. There are a few float boulders of ore on a high hill south of the house. Test pit No. 1 is 6 feet above the float ore on the eastern end of the hill, and pit No. 2 is 150 feet west of No. 1 and has a mouth elevation 10 feet higher than the outcrop. Test pit No. 3 is 900 feet southeast of the house and is north of pits Nos. 1 and 2.

No bauxite or bauxitic clay was found in any of the pits. The following sections show the type of beds encountered:

Section of Tom Hudson test pit No. 1

		Feet
7.	Soil	1.0
Wilcox		
6.	Clay, yellowish-red, and some sand	4.2
5.	Clay, yellow and gray, and a little red clay	6.0
4.	Clay, yellowish-gray	3.5
3.	Slightly bauxitic clay in part of pit	3.0
2.	Clay, reddish-yellow	4.5
1.	Clay, bluish-gray; some sand	1.5

Section of Tom Hudson test pit No. 2

Wilcox		Feet
4.	Clay, reddish-yellow, and sand	6.2
3.	Clay, yellowish-gray	6.0
2.	Clay, gray, plastic	8.4
1.	Clay, bluish-gray	5.0

Section of Tom Hudson test pit No. 3

Wilcox		Feet
3.	Clay, reddish-yellow, and sand	5.0
2.	Clay, yellowish-gray; little sand	7.0
1.	Clay, yellowish-gray, jointed, and some sand	5.0

O. D. Gray Property

The O. D. Gray property, containing 200 acres, consists of 160 acres in the NW. ¼ Sec. 4 and the north 20 acres of W. ½ of SW. ¼ of Sec. 4, and the north 20 acres of E. ½ SE. ¼ of Sec. 5, T. 8 S., R. 1 E. An outcrop of small fragments of yellowish-gray bauxite is found on top of a hill three-fourths mile southwest of the house. Two test pits were sunk on this hill to determine the presence of ore. Test pit No. 1 is at the outcrop on top of the hill and No. 2 is 230 feet west of No. 1. The following sections and analysis show the results of the investigation:

Section of O. D. Gray test pit No. 1

Wilcox		Feet
4.	Clay and soil	2.1
3.	Bauxitic clay, yellowish-gray. Sample No. 83	3.5
2.	Clay, purple, slightly pisolitic	1.6
1.	Clay, reddish-yellow, and some sand	2.6

Analysis of bauxitic clay from O. D. Gray test pit No. 1

	S-83
Aluminum oxide (Al_2O_3)	34.73
Ferric oxide (Fe_2O_3)	8.02
Silicon dioxide (SiO_2)	39.05
Titanium dioxide (TiO_2)	2.00
Loss on ignition	14.55
Moisture	0.80
	99.15

Section of O. D. Gray test pit No. 2

Wilcox	Feet
6. Clay, yellow, sand, and concretions of iron	2.5
5. Sand, gray and yellow	5.7
4. Clay, lignitic, and sand	0.8
3. Sand, gray, and clay	0.8
2. Sand, gray	0.5
1. Clay, gray, and sand	1.7

Tippah County

Topographic and Geologic Location

Tippah County joins Union County on the north and is one of the border counties along the Tennessee line. It is in parts of three physiographic regions: namely, the Pontotoc Ridge, the Flatwoods, and the North Central Plateau. The three terranes, characteristic respectively of these physiographic regions, are the Ripley formation of the upper Cretaceous, and the Midway and Wilcox series of the lower Eocene.

Stratigraphy

There are no bauxite deposits in the Ripley formation, which is the surface terrane in the eastern half of the county. Because the town of Ripley is the type locality and because the beds are associated with bauxite-bearing ones, it seems advisable to describe them, however. The Ripley formation, which is the uppermost division of the Cretaceous in Mississippi, has a thickness of 250 to 300 feet, and consists of more or less calcareous and glauconitic sands, sandy clays, marls, and impure limestones of marine origin. The formation rests conformably on the Selma chalk. From northern Mississippi southward along the strike, the successively higher beds merge into the chalky limestones of the Selma formation. The typical Ripley has not been recognized from Houston to a place near Shuqualak. However, a study of the fossils from a narrow zone along the western border of the Selma chalk has shown them to be of Ripley age. From Shuqualak to the Alabama line the material has more of its typical appearance.

In Mississippi, the Ripley formation has been divided into three members: namely, the Ripley limestone, the Owl Creek marl, and the McNairy sand. The Owl Creek marl, a blue, sandy marl exposed along the bluffs of Owl Creek, three miles northeast of Ripley, is the characteristic bed. It is exposed at places from Pontotoc to the Tennessee line and is fossiliferous wherever found. Some of the common fossil forms are Ostrea, Exogyra, Trigonia, Baculites, Scaphites, Sea Urchins, and fish teeth. On exposure the beds of marl weather to an Indian-red soil of great fertility. The McNairy sand extends from Tennessee through Tippah County and has the greatest thickness of any of the members of the Ripley. It consists of coarse, cross-bedded, vari-colored sands, which are slightly fossiliferous in places. The McNairy is well developed in the rugged Hatchie Hills of the eastern part of the county.

The Midway series has three divisions: the Clayton formation, Porters Creek clay, and Tippah sandstone. It has a thickness of 250 to 300 feet and consists of thin limestones and marls, gray clays, and sands, and lies unconformably on the Ripley and the Selma chalk at different places in the State.

The Wilcox series in the State as a whole has four formations: the Ackerman clay, the Holly Springs sand, the Bashi (Woods Bluff) formation, and the Hatchetigbee (Grenada) formation. It underlies most of the North Central Plateau.

The Ore

The bauxite is in the basal Wilcox, probably in the Ackerman formation near its contact with the underlying Porters Creek clay of the Midway. The ore is in beds which vary in thickness from 1 to 12 feet and which are associated with impure clays and masses of concretionary iron. Five types of ore are found in the county: namely, the pebble, pisolitic, oolitic, vesicular, and the amorphous. More pebble ore is scattered over the surface of the James property than any of the other properties.

There are two groups of deposits in Tippah County: one in the vicinity of Falkner and the other in the vicinity of Blue Mountain.

Falkner and Vicinity

The largest deposits and the best ore in the Falkner neighborhood are in Sec. 4, T. 3 S., R. 3 E., on the I. V. James and Green Wattes properties three miles from the Gulf, Mobile, and Northern Railroad at Falkner. Other deposits of unknown quantities are on properties located farther to the west.

I. V. James Property

(Map 5)

The I. V. James property, containing 20 acres, is in the NE. corner of the NE. ¼ Sec. 4, T. 3 S., R. 3 E. The bauxite is found near the top of an elliptical hill 2,000 feet long and 500 feet wide at the base and 80 feet high. The yellowish-brown, pebble ore outcrops on the sides and top of the hill. In practically all cases the pebbles are completely separated from the matrix. The 555-foot contour represents the base of the bauxite in the hill as shown by the test pits. A much lower outcrop of ore was found at an elevation of 508 feet on the south and west sides of the hill, suggesting the presence of a second bed of bauxite, because the ore from the upper outcrop does not extend down to such a low elevation.

The following sections of test pits and analysis of samples show the results of the investigation:

Section of I. V. James test pit No. 1

Wilcox	Feet
Top of ridge	
2. Bauxite; a hard layer in the upper 2 feet and in the lower foot; the rest is a white bauxite, possibly partially clayey. Sample No. 1	12.0
1. Clay; the lower part is pink in color	1.0

Analysis of bauxite from I. V. James test pit No. 1

	S-1
Aluminum oxide (Al_2O_3)	47.75
Ferric oxide (Fe_2O_3)	2.15
Silicon dioxide (SiO_2)	27.24
Titanium dioxide (TiO_2)	2.40
Loss on ignition	19.76
Non-volatile with HF	0.42
Moisture	0.78
	100.50

Section of I. V. James test pit No. 2

Wilcox	Feet
Top of ridge	
4. Bauxite blocks and covered interval to top of hill	3.5
3. Soil, at mouth of pit	1.0
2. Bauxite, soft	2.5
1. Clay, sand, shale, etc.	8.0

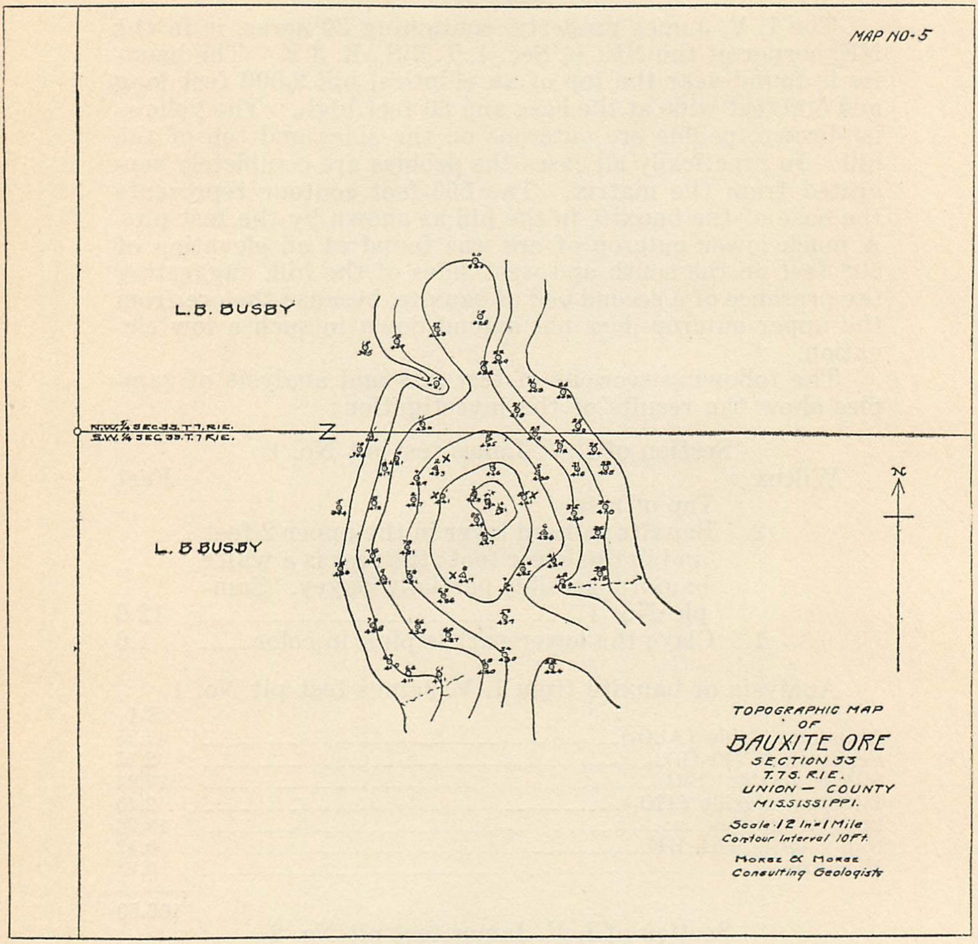

MAP NO-5
L.B. BUSBY
N.W.¼ SEC.33.T.7.R.1E.
S.W.¼ SEC.33.T.7 R.1E.
Z
L. B BUSBY
N
TOPOGRAPHIC MAP
OF
BAUXITE ORE
SECTION 33
T.7S. R.1E.
UNION — COUNTY
MISSISSIPPI.
Scale 12 In=1 Mile
Contour Interval 10 Ft.
Morse & Morse
Consulting Geologists

TABLE VI.—JAMES AND WATTES

PIT		SECTION			ANALYSIS						
Name—	Elevation Feet	Description	Beds Other	Beds Bauxite Feet	Sample No.	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	Loss on ignition	Moisture
I. V. James No. 1	572	Over burden	0.0	--	--	----	----	----	---	----	---
		Bauxite	--	12.0	1	47.75	2.15	27.24	2.40	19.76	0.78
		Clay	1.0	--	--	----	----	----	---	----	---
I. V. James No. 2	559	Over burden	1.0	--	--	----	----	----	---	----	---
		Bauxite	--	2.5	--	----	----	----	---	----	---
		Clay	8.0	--	--	----	----	----	---	----	---
Green Wattes No. 1	501	Float	--	3.5	--	----	----	----	---	----	---
		Bauxite	--	3.5	2	----	----	----	---	----	---
		Clay	1.5	--	--	----	----	----	---	----	---
Green Wattes No. 2	501	Over burden	0.0	--	--	----	----	----	---	----	---
		Bauxite	--	2.5	--	----	----	----	---	----	---
		Iron	0.8	--	--	----	----	----	---	----	---
		Bauxite	--	1.0	--	----	----	----	---	----	---
Green Wattes No. 3	506	Over burden	4.0	--	--	----	----	----	---	----	---
		Bauxite	--	10.3	4	40.58	4.72	26.96	2.20	16.33	9.25
		Clay, bauxitic	0.7	--	--	----	----	----	---	----	---

The top of the bauxite ranges from 562 to 572 feet as shown by Map 5; and the composition is given in Table 6. The estimated tonnage of the hill is:

Ore, Al_2O_3 ---------------------- 48 per cent 26,250 tons

Green Wattes Property

(Map 6)

The Green Wattes property, containing 85 acres, is in the S. ½ NW. ¼ Sec. 4, T. 3 S., R. 3 E. The hill on which the bauxite outcrops is some 700 feet long and 200 feet wide; however, the ore is limited to an area some 300 feet long. The bauxite outcrops around test pit No. 2 at an elevation of 502, whereas the top of the hill has an elevation of 535 feet. Owing to the heavy overburden the highest part of the hill was not prospected; and it is not known whether deposits of ore are present or not.

The following sections of test pits and analysis of samples show the results of the investigation:

Section of Green Wattes test pit No. 1

Wilcox		Feet
	Top of hill	
4.	Bauxite, hard ledge	2.5
	Top of pit	
3.	Soil and subsoil and bauxite float and contorted sandstone	3.5
2.	Bauxite, soft. Sample No. 2	3.5
1.	Clay, white and yellow. Sample No. 3	1.5

Section of Green Wattes test pit No. 2

		Feet
4.	Soil and subsoil	1.0
Wilcox		
3.	Bauxite, soft, clayey	1.5
2.	Sandstone, contorted and ferruginous	0.8
1.	Bauxite, soft, clayey	1.0

Section of Green Wattes test pit No. 3

		Feet
3.	Soil and subsoil, overburden	4.0
Wilcox		
2.	Bauxite, mostly soft. Some of it is in large boulder-like nodules and is stained red with iron ore. The basal foot does not contain so many concretions of oolitic bauxite. Sample from the whole of 10.3 feet except for a 0.2 foot lens of iron sandstone. Sample No. 4	10.3
1.	Clay, white; and a few bauxite oolites	0.7

Analysis of bauxite from Green Wattes test pit No. 3

	S-4
Aluminum oxide (Al_2O_3)	40.58
Ferric oxide (Fe_2O_3)	4.72
Silicon dioxide (SiO_2)	26.96
Titanium dioxide (TiO_2)	2.20
Loss on ignition	16.33
Non-volatile with HF	0.54
Moisture	9.25
	100.58

The top of the ore in pit No. 1 has an elevation of 498 feet; in pit No. 2, an elevation of 501 feet; and in pit No. 3, an elevation of 502 feet. The bauxite varies in thickness in the pits from 2.5 to 10.3 feet. In pit No. 1 the bauxite is overlain by soil and subsoil, float boulders of ore, and contorted sandstone. In test pit No. 2 two beds of bauxite are separated by a layer of contorted, ferruginous sandstone.

From Map 6 and Table 6 the top of the bauxite in the Green Wattes pits 1, 2, and 3 is seen to be 501 and 502 feet in elevation and the ore to range from about 39 to 45 per cent in Al_2O_3. The tonnage is computed to be:

Ore, Al_2O_3	40-45 per cent	18,000 tons

P. W. Caviness Property

The P. W. Caviness property is located about one mile west of the Green Wattes property. One test pit only was sunk on the farm.

Section of P. W. Caviness test pit No. 1

		Feet
	4. Soil and subsoil	2.0
Wilcox		
	3. Bauxitic clay, soft, yellow. Sample No. 9	3.0
	2. Bauxite; irregular, nodular masses of hard, ferruginous ore in a matrix in part of soft, bauxitic clay. Sample No. 10	2.5
	1. Bauxitic clay, soft, white. Sample No. 11	2.5

The ore in this pit is very irregular. There are a number of joints which are filled with iron ore.

Analyses of bauxite from P. W. Caviness test pit No. 1

	S-9	S-10	S-11
Aluminum oxide (Al_2O_3)	32.44	30.62	37.90
Ferric oxide (Fe_2O_3)	8.06	25.88	5.90
Silicon dioxide (SiO_2)	38.86	22.26	29.96
Titanium dioxide (TiO_2)	0.50	0.90	1.20
Loss on ignition	11.92	15.30	15.00
Non-volatile with HF	1.74	2.60	2.16
Moisture	7.45	3.12	8.89
	100.97	100.68	101.01

Property W. D. Shelton and Others

On the land of W. D. Shelton, 2½ miles east of Finger's Store, the bauxite is poorly exposed. The ore extends onto the land of James Strickland and of Bryant Janes. but on all three of the farms the overburden is very great, probably prohibitive, except about the brow of the hills.

On the J. B. Childers farm, hard bauxite is exposed on the banks of the stream and softer ore in the bed of the stream six or seven feet lower. The banks and bed of the stream probably represent the limits of the thickness of the ore bed. On the adjoining farm of S. S. Finger, the bauxite outcrops between the Childers and McGill (Benton County) places. One block measures over 4 feet in thickness.

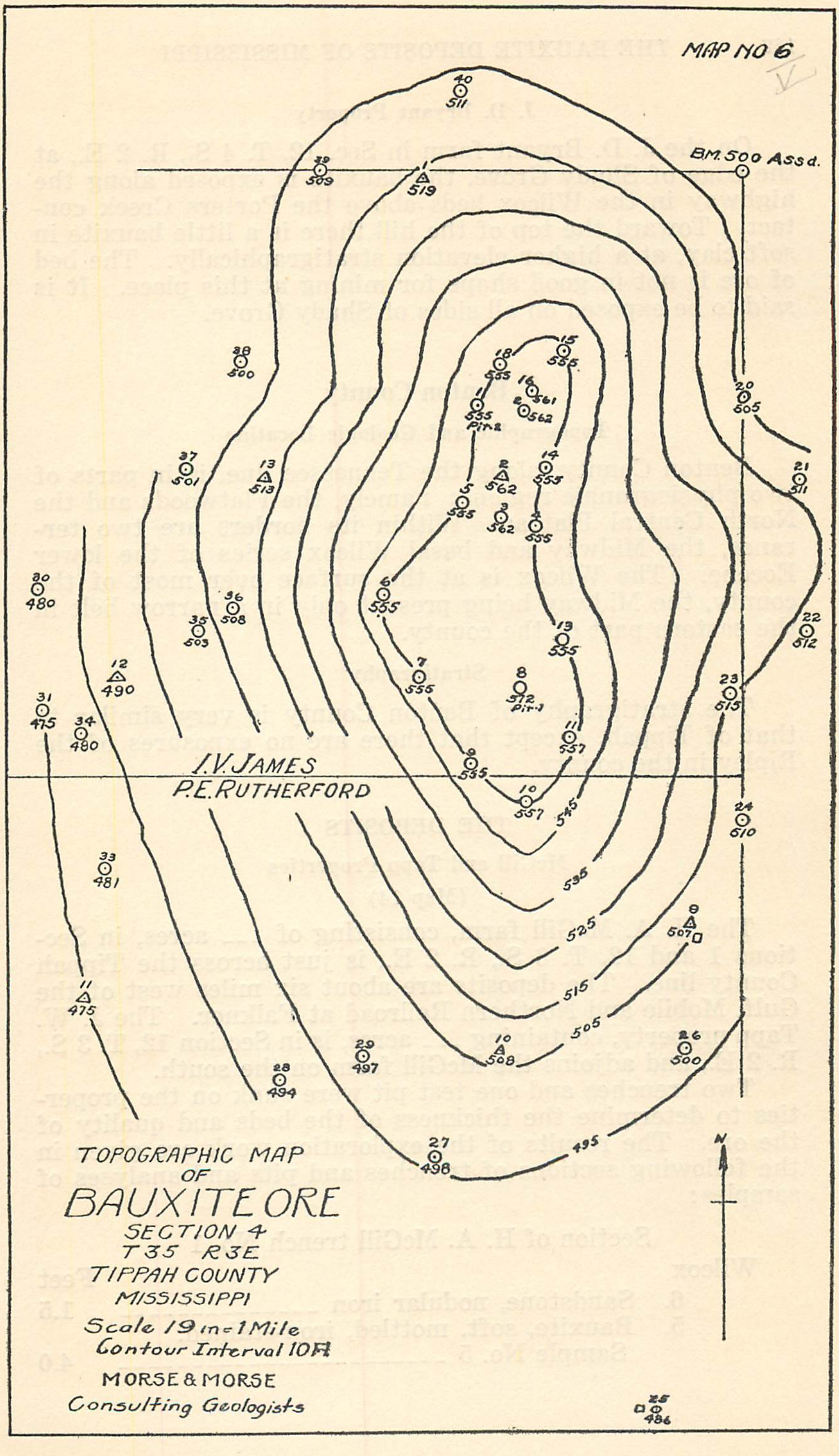
Based on the location of the P. W. Caviness deposits, there seems to be a belt of ore extending from the I. V. James community to that of the McGill in Benton County.

Blue Mountain and Vicinity

Just west of Blue Mountain on the north side of the ridge are two or three spurs on the very tips of which is a small amount of bauxite. The spur ridges are too low for the deposit to be of any importance. In the highway 2½ miles southwest of Blue Mountain is a bed of white clay material in which are clay pebbles or bauxite concretions.

Graham and Hudspeth Properties

On Messrs. Graham and Hudspeth's farm 1½ miles southwest of Blue Mountain, in Sec. 12, T. 6 S., R. 2 E., the bauxite is exposed at the top of the hill. It is 4 feet in thickness, white in color, without iron, and low in silica. Some of it is vesicular since the oolites have dropped out of the surface. The ridge is 80 feet wide and 350 feet long.


MAP NO 6
40 511
BM. 500 Ass d.
39 509
1 519
38 500
15 555
18 555
16 561
2 562
1 555 Pit 2
20 505
37 501
13 513
2 562
14 555
21 511
5 555
3 562
4 555
30 480
6 555
36 508
35 503
13 555
22 512
12 490
7 555
8 572 Pit 1
23 515
31 475
34 480
11 557
I.V. JAMES
P.E. RUTHERFORD
9 555
10 557
545
24 510
33 481
535
9 507
525
515
11 475
505
10 508
29 497
26 500
28 494
27 498
495
N
TOPOGRAPHIC MAP
OF
BAUXITE ORE
SECTION 4
T 3S R 3E
TIPPAH COUNTY
MISSISSIPPI
Scale 19 in = 1 Mile
Contour Interval 10 Ft
MORSE & MORSE
Consulting Geologists
25 486

J. D. Bryant Property

On the J. D. Bryant farm in Sec. 12, T. 4 S., R. 2 E., at the edge of Shady Grove, the bauxite is exposed along the highway in the Wilcox beds above the Porters Creek contact. Toward the top of the hill there is a little bauxite in soft clay, at a higher elevation stratigraphically. The bed of ore is not in good shape for mining at this place. It is said to be exposed on all sides of Shady Grove.

Benton County

Topographic and Geologic Location

Benton County, along the Tennessee line, is in parts of two physiographic regions: namely, the Flatwoods and the North Central Plateau. Within its borders are two terranes, the Midway and basal Wilcox series of the lower Eocene. The Wilcox is at the surface over most of the county, the Midway being present only in a narrow belt in the eastern part of the county.

Stratigraphy

The stratigraphy of Benton County is very similar to that of Tippah, except that there are no exposures of the Ripley in the county.

THE DEPOSITS

McGill and Tapp Properties

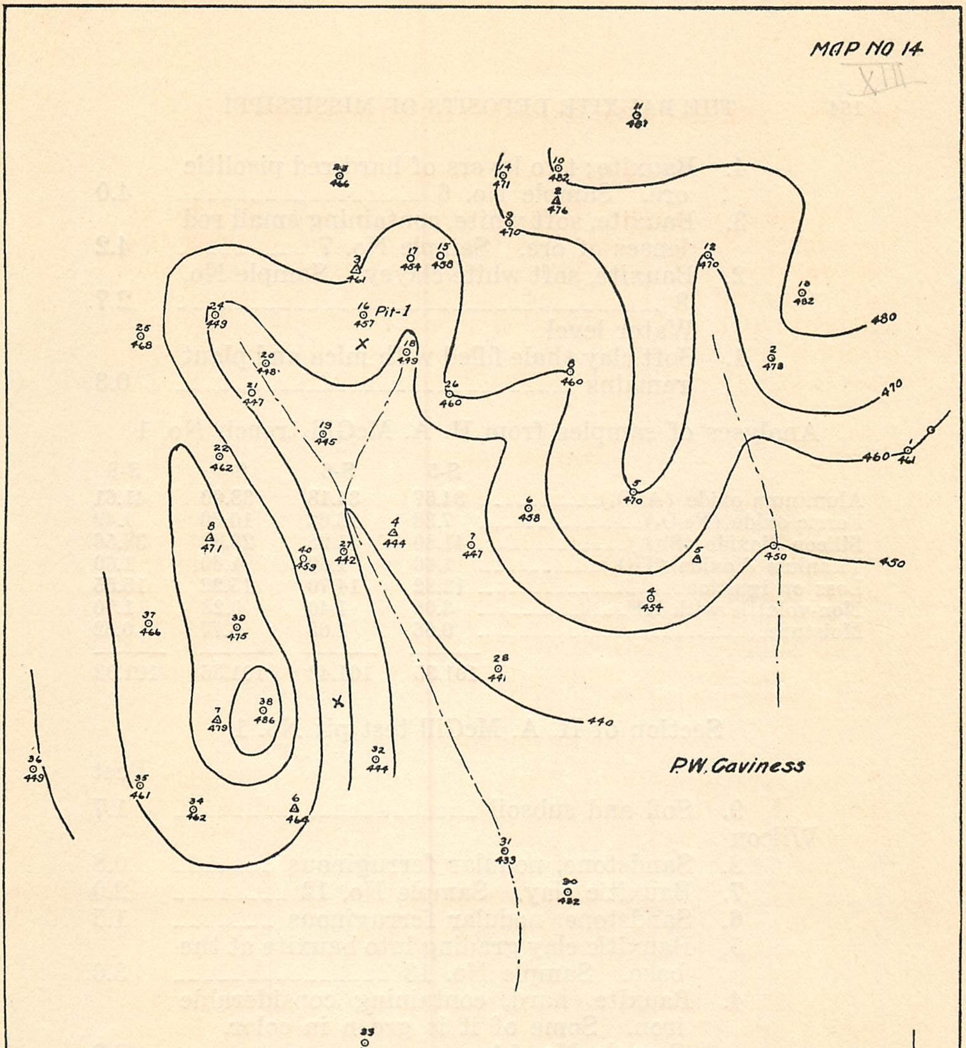
(Map 14)

The H. A. McGill farm, consisting of --- acres, in Sections 1 and 12, T. 3 S., R. 2 E., is just across the Tippah County line. The deposits are about six miles west of the Gulf, Mobile and Northern Railroad at Falkner. The J. W. Tapp property, containing --- acres, is in Section 12, T. 3 S., R. 2 E., and adjoins the McGill farm on the south.

Two trenches and one test pit were sunk on the properties to determine the thickness of the beds and quality of the ore. The results of the exploration work are given in the following sections of trenches and pits and analyses of samples:

Section of H. A. McGill trench No. 1

Wilcox		Feet
	6. Sandstone, nodular iron	1.5
	5. Bauxite, soft, mottled, iron-stained. Sample No. 5	4.0


MAP NO 14
XIII
TOPOGRAPHIC MAP
OF
BAUXITE ORE
SECTION 5
T3S R3E
TIPPAH COUNTY
MISSISSIPPI
Scale 16" = 1 MILE
Contour Interval 10 Ft.
MORSE & MORSE
Consulting Geologists
P.W. Gaviness
Pit-1
B.M.
480
470
460
450
440

4.	Bauxite; two layers of hard red pisolitic ore. Sample No. 6	4.0
3.	Bauxite, soft white, containing small red lenses of ore. Sample No. 7	4.2
2.	Bauxite, soft white clayey. Sample No. 8	2.7
	Water level	
1.	Soft clay shale filled with mica and plant remains	0.3

Analyses of samples from H. A. McGill trench No. 1

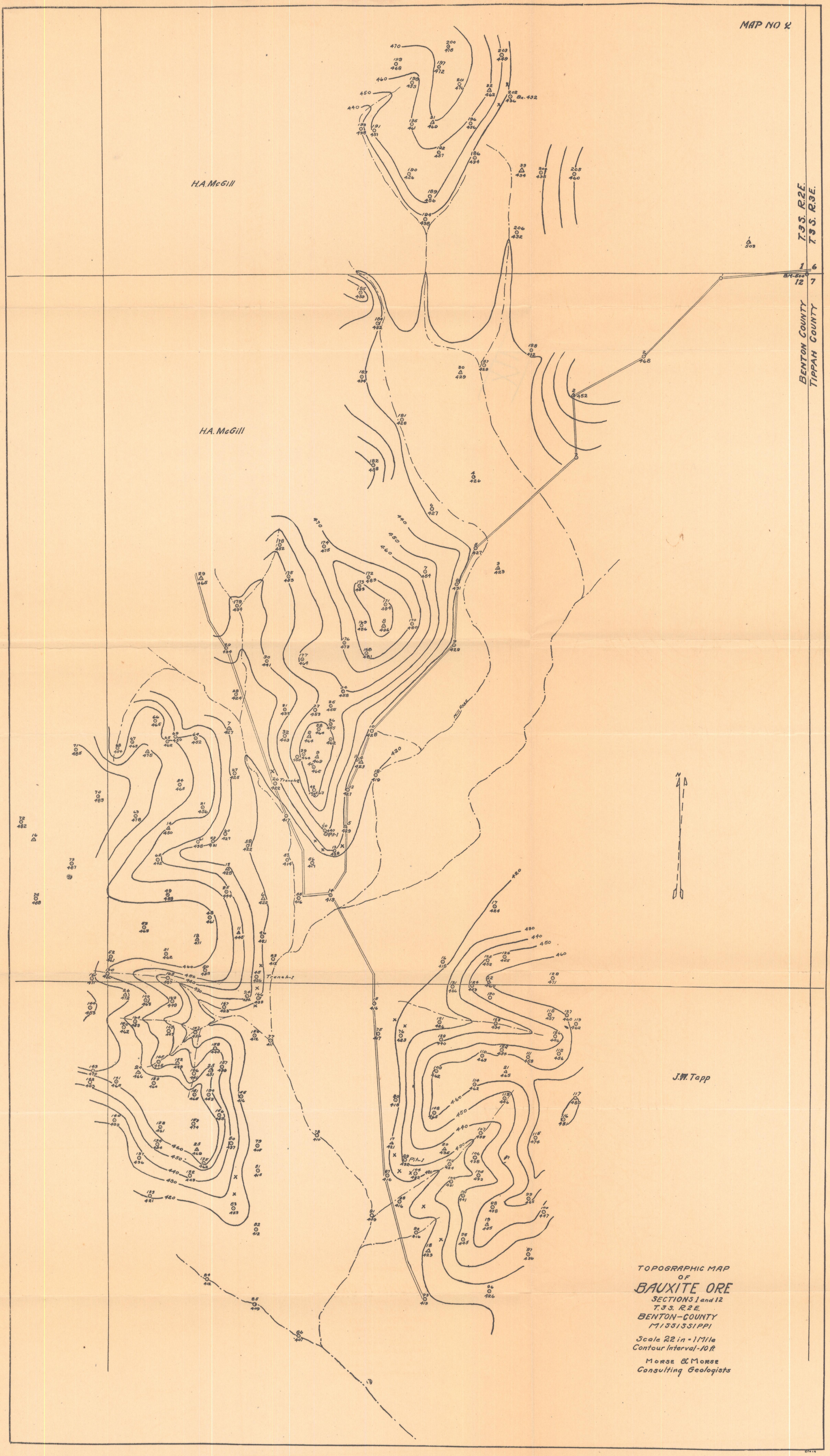
	S-5	S-6	S-7	S-8
Aluminum oxide (Al_2O_3)	34.57	34.18	38.00	41.61
Ferric oxide (Fe_2O_3)	7.33	16.62	10.60	1.49
Silicon dioxide (SiO_2)	41.80	31.28	28.88	38.56
Titanium dioxide (TiO_2)	1.60	1.60	1.60	1.60
Loss on ignition	12.32	14.70	15.22	15.55
Non-volatile with HF	3.08	1.40	0.28	1.70
Moisture	0.65	1.65	6.77	0.52
	101.35	101.43	101.35	101.03

Section of H. A. McGill test pit No. 1

			Feet
	9.	Soil and subsoil	1.7
Wilcox			
	8.	Sandstone, nodular ferruginous	0.8
	7.	Bauxitic clay. Sample No. 12	2.0
	6.	Sandstone, nodular ferruginous	1.5
	5.	Bauxitic clay grading into bauxite at the base. Sample No. 13	3.0
	4.	Bauxite, hard, containing considerable iron. Some of it is green in color. Sample No. 14	3.0
	3.	Clay, yellow; black markings	1.2
	2.	Sandstone, white, ferrous	0.8
	1.	Clay, yellow; black markings	2.5

Analyses of samples from H. A. McGill test pit No. 1

	S-12	S-13	S-14
Aluminum oxide (Al_2O_3)	29.64	32.45	29.60
Ferric oxide (Fe_2O_3)	9.06	10.05	32.00
Silicon dioxide (SiO_2)	39.30	33.88	14.80
Titanium dioxide (TiO_2)	0.60	0.70	0.80
Loss on ignition	11.00	12.66	15.90
Non-volatile with HF	8.54	3.92	1.60
Moisture	2.54	6.84	5.33
	100.68	100.50	100.03



TOPOGRAPHIC MAP
OF
BAUXITE ORE
SECTIONS 1 and 12
T.3S. R.2E.
BENTON-COUNTY
MISSISSIPPI

Scale 22 in = 1 Mile
Contour Interval - 10 ft.

Morse & Morse
Consulting Geologists

In trenches 1 and 2 and pit 1 on the H. A. McGill farm and in pit 1 on the J. W. Tapp farm (Map 14) the top of the bauxite ranges from about 422 to 432 feet and the composition of the ore (Table 11) from 31 to 42 per cent. These test trenches and pits are not sufficient to give the full extent of the ore, but the number and continuity of the outcrops at the base of the hills are sufficient to warrant the following estimates for the respective farms. No doubt, further exploration would show a larger tonnage.

Tonnage of McGill and Tapp properties

H. A. McGill

Ore, Al_2O_3	31 per cent	405,333 tons
Ore, Al_2O_3	34-42 per cent	140,000 tons
Total		545,333 tons

J. W. Tapp

Ore, Al_2O_3	34-42 per cent	190,000 tons

Calhoun County

Calhoun County, in the north central part of the state, borders Chickasaw County on the west and touches the southwest corner of Pontotoc County. Practically the entire county is in the North Central Plateau which is underlain by the Wilcox series.

Some small boulders of bauxite are found on the surface one mile west of Sarepta. The small outcrop consists of low grade material. Surface indications suggest a small deposit of low grade ore that is not of any commercial importance.

Another small deposit, the full extent of which has not been worked out in detail, is found about three miles northeast of Sarepta. This is a red ore of very good quality.

Webster County

Topographic and Geologic Location

Webster County joins Calhoun County on the south. It is in parts of two physiographic regions: namely, the North Central Plateau and the Flatwoods. In the greater part of the county, the North Central Plateau region, the Wilcox series is at the surface. In a narrow belt in the eastern part of the county, the Midway series outcrops.

TABLE X.—P. W. CAVINESS

PIT		SECTION				ANALYSIS					
Name—	Elevation Feet	Description	Beds Other Feet	Beds Bauxite Feet	Sample No.	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	Loss on ignition	Moisture
P. W. Caviness No. 1	457	Over burden	2.0	--	--	----	----	----	---	----	---
		Bauxite	--	3.0	9	32.44	8.06	38.86	0.50	11.92	7.45
		Bauxite	--	2.5	10	30.62	25.88	22.26	0.90	15.30	3.12
		Bauxite	--	2.5	11	37.90	5.90	29.96	1.20	15.00	8.89

TABLE XI.—McGILL AND TAPP

PIT		SECTION				ANALYSIS					
Name—	Elevation Feet	Description	Beds Other Feet	Beds Bauxite Feet	Sample No.	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	Loss on ignition	Moisture
H. A. McGill No. 1	440	Over burden	2.5	--	--	----	----	----	---	----	---
		Clay, bauxitic	--	2.0	12	29.64	9.06	39.30	0.60	11.00	2.54
		Sandstone	1.5	--	--	----	----	----	---	----	---
		Bauxite	--	3.0	13	32.45	10.05	33.88	0.70	12.66	6.84
		Bauxite	--	3.0	14	29.60	32.00	14.80	0.80	15.90	5.33
		Clay	1.5	--	--	----	----	----	---	----	---
H. A. McGill J. W. Tapp	Trench No. 1-426	Over burden	1.5	--	--	----	----	----	---	----	---
		Bauxite	--	4.0	5	34.57	7.33	41.80	1.60	12.32	0.65
		Bauxite	--	4.0	6	34.18	16.62	31.28	1.60	14.70	1.65
		Bauxite	--	4.2	7	38.00	10.60	28.88	1.60	15.22	6.77
		Bauxite	--	2.7	8	41.61	1.49	38.56	1.60	15.55	0.52
		Clay	0.3	--	--	----	----	----	---	----	---

The Ore

Some bauxitic clay has been found at two places in the county: (1) in the vicinity of Cumberland and (2) in the vicinity of Mathiston. The deposits three miles northwest of Cumberland are small and of little importance. Those one mile east of Mathiston and those three miles north of the same town are pisolitic clays which are only slightly bauxitic.

The clays in the highway cut on the Maben road one mile from Mathiston are in the exposed Wilcox sands. These sands are reddish-yellow, cross-bedded, and ferruginous, and alternate with layers which are mostly clay, but which contain some grains of sand completely covered with clay. The white clay, having a pisolitic structure, contains some rounded masses which are concretions or lumps. These particles vary in size from one-sixteenth to three-quarters of an inch in diameter, and many of them are clay. The red sands contain small nodules of white clay, at places.

The lowest layer exposed is a reddish-yellow sand. Above, in order, are: a layer of clay, having pisolitic structure; reddish sand; pisolitic clay; reddish sand; clay; sand; and soil and sub-soil. The clays are interbedded with the sands and are fairly continuous, being exposed for a distance of 150 feet in the cut.

The following analysis is from a surface sample of the pisolitic clay:

Aluminum oxide (Al_2O_3)	32.20
Ferric oxide (Fe_2O_3)	0.00
Silicon dioxide (SiO_2)	34.76
Titanium dioxide (TiO_2)	1.80
Loss on ignition	10.03
Non-volatile with HF	21.18
Moisture	0.20
	100.17

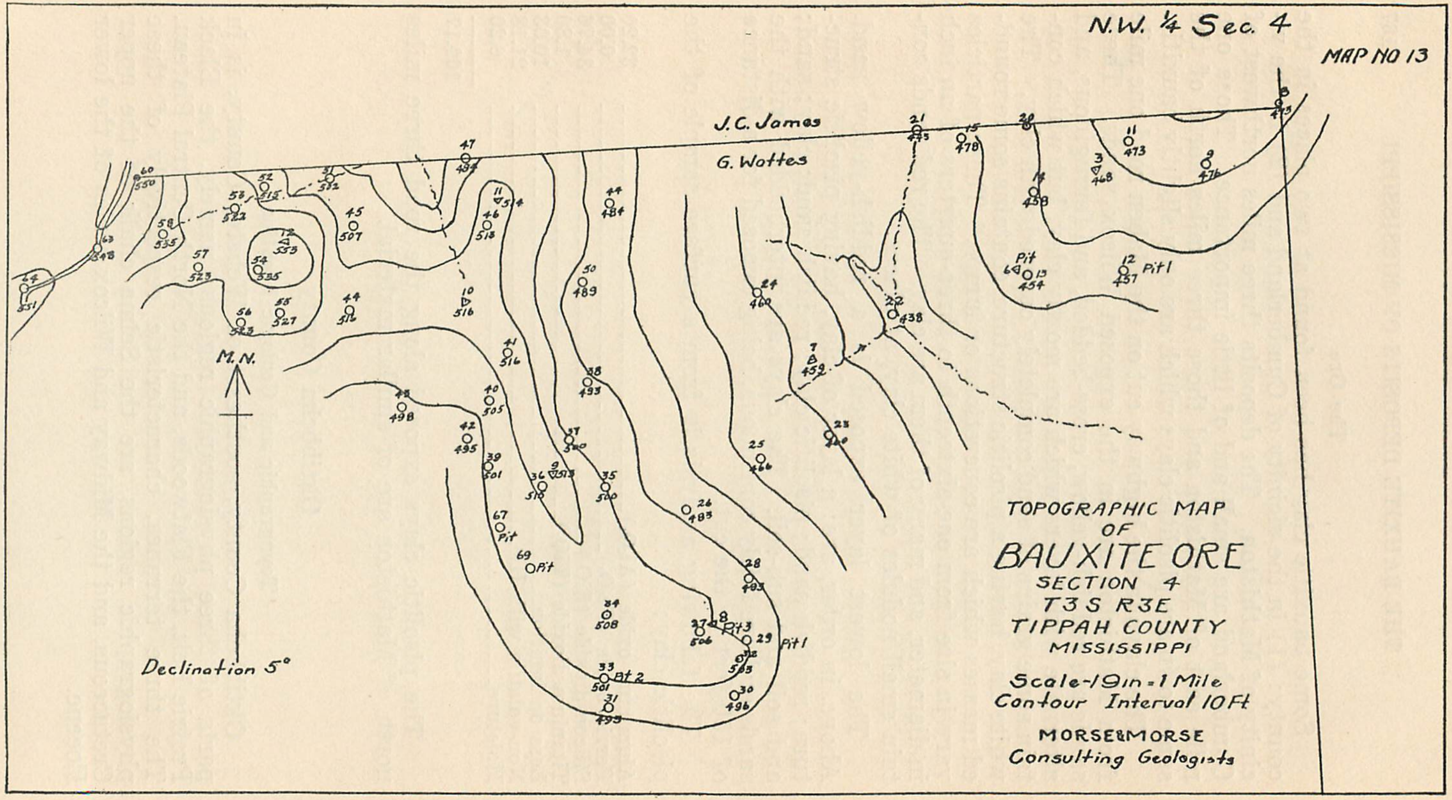
The pisolitic clays exposed along the road three miles north of Mathiston are of similar material.

Oktibbeha County

Topographic and Geologic Location

Oktibbeha County, southeast of Webster County, is in parts of three physiographic regions: namely, the Black Prairie Belt, the Flatwoods, and the North Central Plateau. The three terranes, characteristic respectively of these physiographic regions, are the Selma chalk of the upper Cretaceous, and the Midway and Wilcox series of the lower Eocene.

VI


N.W. 1/4 Sec. 4
MAP NO 13
J.C. James
G. Wottes
M.N.
Declination 5°
TOPOGRAPHIC MAP
OF
BAUXITE ORE
SECTION 4
T3S R3E
TIPPAH COUNTY
MISSISSIPPI
Scale-19in=1 Mile
Contour Interval 10 Ft
MORSE & MORSE
Consulting Geologists
Pit
Pit 1
Pit 2
Pit 3
8 473
21 475
15 478
20
11 473
9 476
3 468
14 458
13 454
12 457
22 438
7 459
23 460
24 460
25 466
26 485
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40 505
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42 495
43 498
44 484
44 512
45 507
46 518
47 494
50 489
51 532
52 515
53 522
54 535
55 527
56 523
57 523
58 535
60 550
63 548
64 551
10 516
11 514
12 553
67
69

Stratigraphy

The stratigraphy is similar to that of counties already described and need not be repeated.

The Ore

Only one deposit of bauxite is known in the county. It is one mile east of Sturgis in Sec. 10, T. 17 N., R. 12 E. The main outcrop of the medium hard, pisolitic ore forms the bed of an old road that crosses the end of a short ridge. Lesser outcrops are at the other end and at various places on top of the hill; and small pebbles and boulders of ore show around the bases of the pine trees at numerous places. This hill has undoubtedly been held up by the hard bed of ore. Most of the bauxite seems to be limited to this hill, which is 885 feet in length and 125 feet in average width.

The Porters Creek clays of the Midway series are exposed in the cut of the Illinois Central Railroad nearby. They are typical Porters Creek. The hard, brownish, pisolitic bauxite is in the Ackerman formation of the Wilcox series, aproximately 30 feet above the Porters Creek clays. Some of the ore is still higher in the hill and is associated with beds of reddish sand that are typical of the Wilcox.

On an adjacent hill a spring issues on top of beds of clay 20 to 30 feet below an outcrop of bauxite boulders. These boulders, however, may represent float ore and may have been let down from a higher elevation.

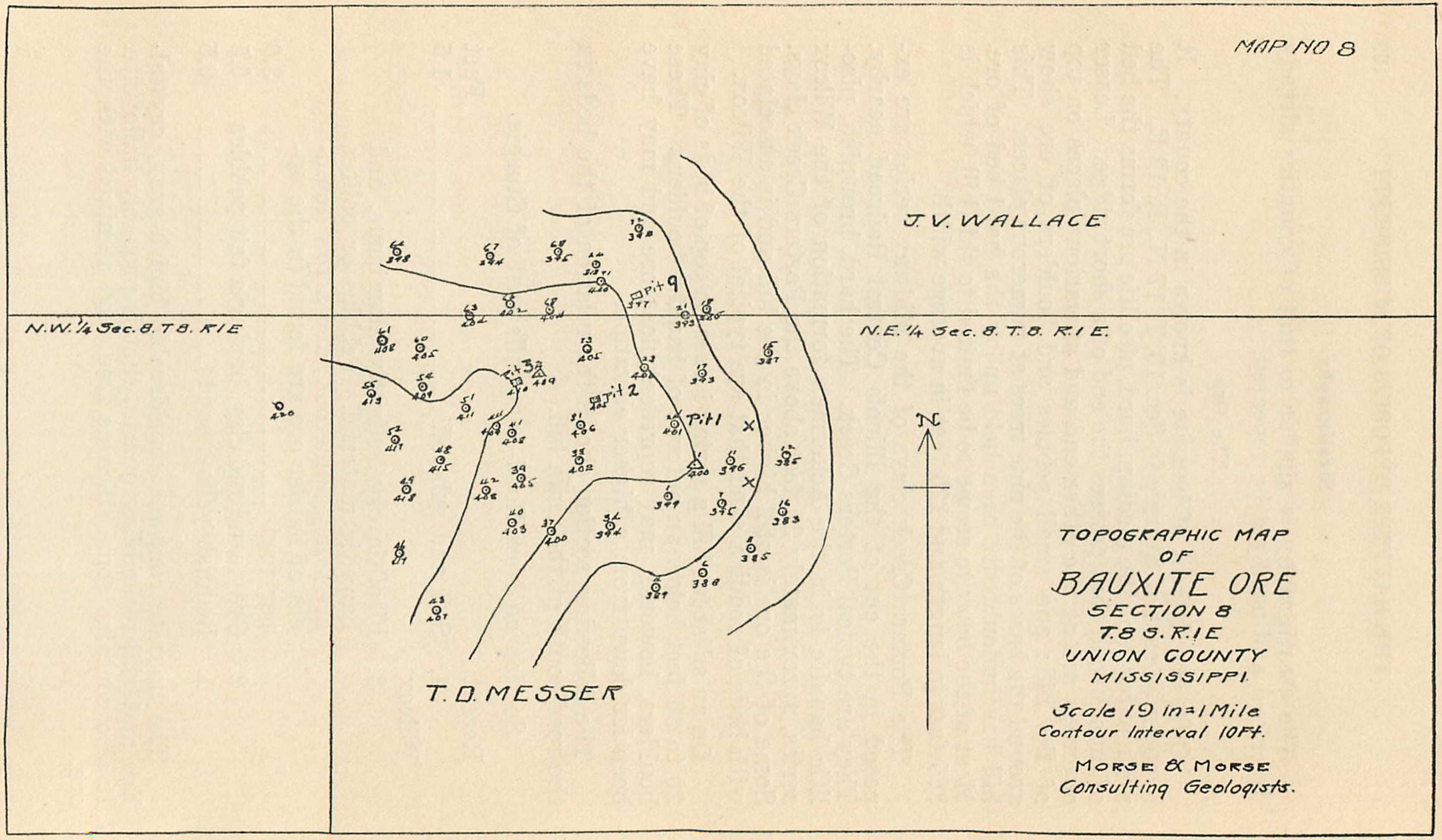
The following section shows the relation of the beds in the road south of the main hill.

Section on New Road—one mile east of Sturgis.

		Feet
Recent		
4.	Soil and sub-soil	1.5
Wilcox		
3.	Pisolitic clay, slightly aluminous, and bauxitic material. Pebbles or oolites are fairly numerous; and a few boulders of harder ore are found in the upper part	3.0
2.	Gray sand and clay, having a few pebbles	0.5
1.	Reddish yellow sand	0.5

The bauxite contains considerable bluish-gray, crystalline material resembling quartz, that is probably halloysite. It also contains some silica as free sand admixed with the ore.

XII


MAP NO 8
J. V. WALLACE
N.W. ¼ Sec. 8. T8. R1E
N.E. ¼ Sec. 8. T. 8. R. 1 E.
Pit 9
Pit 3
Pit 2
Pit 1
N
T. D. MESSER
TOPOGRAPHIC MAP
OF
BAUXITE ORE
SECTION 8
T.8 S. R.1E
UNION COUNTY
MISSISSIPPI
Scale 19 in=1 Mile
Contour Interval 10Ft.
MORSE & MORSE
Consulting Geologists.

The following analysis shows the quality of the brown, pisolitic ore that outcrops on the main ridge or hill:

Aluminum oxide (Al_2O_3)	34.91
Ferric oxide (Fe_2O_3)	1.19
Silicon dioxide (SiO_2)	32.70
Titanium dioxide (TiO_2)	1.19
Loss on ignition	12.35
Non-volatile with HF	15.98
Moisture	1.75

Winston County

Topographic and Geologic Location

Winston County is entirely in the North Central Plateau except for a small area in the northeastern part of the county which is in the Flatwoods. The Wilcox sands are characteristic of the Plateau regions and the Porters Creek clay of the Flatwoods.

Stratigraphy

The Midway series has a thickness of 250 to 300 feet; consists of thin limestones and marls, gray clays, and sands; and lies unconformably on the Ripley and the Selma chalk at different places in the state. The series has three divisions: the Clayton formation, the Porters Creek clay, and the Tippah sandstone. Only the gray clays of the Porters Creek, however, outcrop in the northeastern part of the county.

The Ackerman clay and Holly Springs sand of the Wilcox series are at the surface over almost the entire county.

The Ore

High grade, brown, pisolitic bauxite outcrops on the Sullivan property, two miles north of Fearns Springs.

J. W. Sullivan Property

The J. W. Sullivan property, containing 300 acres, is in Sec. 27, T. 14 N., R. 14 E. Large boulders, one to three feet in diameter, of medium hard, brown, pisolitic bauxite outcrop on a ridge near the old house in the NW. 1/4 of Sec. 27. The hill is about 700 feet in length and averages 100 to 150 feet in width. The ore outcrops on practically the highest part of the ridge and makes a fine surface showing.

The Republic Mining and Manufacturing Company drilled five Empire Drill wells on this one hill (NW. 1/4 Sec. 27) in prospecting the property. The first well is near the barn and is a few feet above the outcrop. The second well is 50 feet from the outcrop of bauxite and has approximately the same elevation. The other wells are 100 to 125 feet apart and are on the crest of the hill. All of them, however, except No. 1, are below the main outcrop. The wells range from 8 to 35 feet in depth, according to Mr. Sullivan. At the time of the writer's visit to the property in October, 1922, immediately after the wells were drilled, the cuttings seemed to indicate that the wells penetrated soil and subsoil, and reddish sand, and stopped in a bluish-gray and blue, plastic clay.

The same company sank about six Empire Drill wells on a hill in the NE. 1/4 of Sec. 27. The surface showing there consists of a few scattered boulders of brown, pisolitic bauxite. A few small boulders of ore are also found in the adjacent part of Sec. 28; and Mr. Sullivan reports that one well was sunk in this part. Seemingly all the bauxite in the area prospected has been let down from a higher elevation. Further prospecting on other parts of the farm might reveal the presence of ore.

The following analysis shows the quality of surface bauxite on the Sullivan property:

Aluminum oxide (Al_2O_3)	55.84
Ferric oxide (Fe_2O_3)	4.56
Silicon dioxide (SiO_2)	15.04
Titanium dioxide (TiO_2)	1.80
Loss on ignition	21.92
Non-volatile with HF	1.62
Moisture	0.30
	101.08

Other Properties

Gray bauxitic clay has been reported from the T. C. Hemphill and the J. H. Hurt farms. Both are near the Sullivan property, the J. H. Hurt farm being in Sec. 22, T. 14 N., R. 14 E.

Bauxitic clay also has been reported on the J. H. Anderson farm in Sec. 11, T. 13 N., R. 14 E., one mile south of Fearns Springs.

Bauxitic clay has been reported from the vicinity of Betheden in the northern part of the county; however, the writer was not able to find any bauxite or bauxitic clay in this area.

Noxubee County

Topographic and Geologic Location

Noxubee County joins Winston County on the east and is in the eastern part of the state, being a border county along the Alabama line. It is in parts of three physiographic regions: namely, the Black Prairie Belt, the Flatwoods, and the North Central Plateau. The three terranes, characteristic respectively of these three physiographic regions, are the Selma chalk of the upper Cretaceous, and the Midway and Wilcox series of the lower Eocene.

Stratigraphy

The stratigraphy of the county is similar to that of Winston County and need not be described.

The Ore

The brown, pisolitic bauxite outcrops as boulders along the road on the W. J. Hubbard, Sr. property in Sec. 8, T. 13 N., R. 15 E.

The W. J. Hubbard, Sr. Property

The W. J. Hubbard, Sr. farm, consisting of 320 acres, is in Sec. 8, T. 13 N., R. 15 E. A few small boulders of brown, pisolitic bauxite are found along the road near the center of Sec. 8. In the S. ½ of the NW. ¼ and the N. ½ of the SW. ¼ several trenches a few feet in depth have been dug by the owners. The boulders of ore at the surface contain considerable clay and ferruginous material. The material from the test trenches as shown by the dump is clayey for the most part. These deposits are about 13 miles west of Shuqualak and about 15 miles by road. Shuqualak, on the Mobile and Ohio Railroad, would be the nearest shipping point.

The following analyses show the quality of the surface bauxite: the first (a) from the center of Sec. 8, the second (b) from the west half of the same section:

	(a)	(b)
Aluminum oxide (Al_2O_3)	53.32	39.30
Ferric oxide (Fe_2O_3)	4.68	12.40
Silicon dioxide (SiO_2)	16.18	29.64
Titanium dioxide (TiO_2)	2.00	1.60
Loss on ignition	23.17	15.32
Non-volatile with HF	----	1.08
Moisture	0.65	1.37
	100.00	100.71

F. J. Hubbard and W. H. Hubbard Property

The F. J. Hubbard and W. H. Hubbard property in Sec. 7, T. 13 N., R. 15 E., comprises about 300 acres. Some bauxitic clay outcrops at a few places on the farm. There are not enough outcrops, however, to determine the presence of a deposit of ore. A few test pits or trenches located at favorable places might give a clew as to the presence of ore in commercial quantities.

Mat Liddell Property

The Mat Liddell (Colored) farm containing 80 acres is in Sec. 8, T. 13 N., R. 15 E. A few boulders of sandy bauxite have been found in the NW. ¼, NW. ¼ of Sec. 8. The boulders on the hill north of the house are very sandy and of poor grade as is the material near the spring. The deposit is not considered to be of any commercial importance.

The T. H. Hurst Property

The T. H. Hurst property consists of 360 acres in Sec. 6, T. 13 N., R. 15 E., in Noxubee County and 120 acres in NE. ¼ Sec. 1, T. 13 N., R. 14 E., in Winston County. The rocks in SE. ¼ of Sec. 6, which was the part visited by the writer, consist largely of red ferruginous sandstone. Some of the sandstone shows a slight oolitic structure. No outcrops of bauxite have been found.

Kemper County

Kemper County joins Noxubee County on the south and is also a border county along the Alabama line. Only one deposit of bauxite has been found in the county—on the J. C. Flora property, containing 400 acres, in Sec. __, T. 12 N., R. 16 E., about six miles southwest of Shuqualak. The boulders of brown, pisolitic, bauxite outcrop for a distance of 250 feet along the edge of a small hill. The boulders of ore vary from one to two or three feet in diameter and are of good grade. The hill, however, has a maximum width of only 50 or 60 feet. Assuming a thickness of two feet for the bed of ore, the hill would contain approximately 1,500 tons. The only way to closer estimate the quantity of ore would be to sink several test pits through the beds. Scattered blocks of ore are found beyond the limits of the hill; most of these boulders are less than a foot in diameter. Sand hills surround the bauxite on all sides. The Futvoye and Patterson Lumber Company's logging road is about four and one-half miles from the deposit.

The following analysis shows the character of the surface bauxite:

Aluminum oxide (Al_2O_3)	54.95
Ferric oxide (Fe_2O_3)	0.15
Silicon dioxide (SiO_2)	16.94
Titanium dioxide (TiO_2)	1.60
Loss on ignition	23.45
Non-volatile with HF	3.70
Moisture	0.60
	101.39

TECHNOLOGY OF BAUXITE

Mining Methods

Bauxite is mined in the United States by open pit methods. The largest mining operations in the world are at Bauxite, Saline County, Arkansas. The American Bauxite Company, a subsidiary of the Aluminum Company of America, is the greatest producer. The bed containing the merchantable ore averages about 11 feet in thickness, dips at a low angle, and is overlain by a loose sandy clay. Mining was by hand methods until the overburden became too heavy. According to Ladoo, the stripping at the present time varies from 25 to 140 feet. "This overburden is removed by steam shovels, loaded into large automatic side-dump waste cars, and hauled in train loads by a steam locomotive to a waste dump, which is located over an area of barren granite rock."[96] Throughout the ore beds, clay horses are so numerous that, on the average, 40 per cent of the material handled in mining must be discarded as waste. Even this amount is greatly exceeded in some places.

"The shovels are sometimes unable to remove all the overburden from low places and pockets in the surface, and the cleaning up is done with horse-drawn scrapers. As it is important that the silica content of the bauxite be kept as low as possible, the stripped surface of the ore is further cleaned and swept by hand. The ore is loosely consolidated, but is usually too hard to be mined without breaking up by blasting. Low-strength dynamite is used for this work. The loosened ore is loaded by small steam shovels into two-ton, wooden, bottom-dump-cars, which are hauled over a narrow-gauge track to the mill, in trains of ten to twenty-five cars, by small steam locomotives. The bed is so extensive that a continuous working face a mile long is possible. The problem of drainage, which was once serious, has been solved by cutting a small canal, a mile in length, to drain all workings."[97]

In the Appalachian fields practically all the mining, including the removing of the overburden, has been done by manual labor. In central Georgia the overburden of sand and clay ranges from ten to sixty feet. The maximum known thickness of ore is about ten feet; and overburden as heavy as 48 feet (Sweetwater Mine) has been moved in places to recover five or six feet of ore. In the past the bauxite and overburden have been trammed to the dump by

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[96] Ladoo, Raymond B., Bauxite; occurrence, mining, and uses. Eng. and Min. Jour. Press, vol. 114, pp. 805-809, 1922.

[97] *Loc. cit.*

hand or mule power. The material is so soft that blasting is rarely necessary.

According to T. Poole Maynard, "the engineer who for the first time observes bauxite mining in the Appalachian Valley field would be amazed to see clays and low-grade bauxites carted away in wheelbarrows, the ore mined by pick and shovel and raised from these funnel-shaped openings by skips and aerial cableways. Although the deposits are above water level, the large 'V' shaped pits are usually drained by pumps and during rainy seasons these pits are 'loblollys' and the cost of mining made prohibitive, due in part to the nature of the deposits and in part to natural human tendencies where there is a monopoly of anything.

"It is evident from what has been said about the bauxite deposits that:

"1. The present methods of mining are wasteful. Many bauxite mines have been abandoned, it proving unprofitable to work many deposits of low-grade, or even win the high-grade ores on account of the large number of clay 'horses,' or the proportion of clay to bauxite being greater than could be worked profitably by hand methods.

"2. That in any event only the mines most favorably located with relation to transportation and overburden, or deposits of high-grade could be worked profitably on account of the high cost of mining.

"3. Large deposits of low-grade bauxites of 45 to 50 per cent alumina-content have not been considered of commercial interest.

"4. Independent corporations have been kept out of the field on account of the practical impossibility of getting sufficient tonnage of bauxite to warrant commercial development other than on a very small scale.

"5. The development of the industries dependent upon bauxite for their raw material has been retarded by the lack of confidence of capital that they could be assured a supply."[98]

Preparation of the Ore

The bauxites in the United States commonly contain from 15 to 33 per cent of combined water, and a varying amount of mechanically held moisture. The larger producers usually dry the ore before shipment, in order to save freight and to facilitate fine grinding for later use. Some of the smaller producers in the Appalachian field have ship-

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[98] Maynard, T. Poole, Bauxite and Aluminum, Chem. Age, vol. 30, pp. 86-88, 1922.

ped the ore undried or "green." To concentrate the ore, bauxite mixed with clay has been passed through log washers, but such treatment is not common at present.

"In Arkansas the American Bauxite Company dumps the ore from the mine cars into large bins, from the bottoms of which it is removed by pan feeders. Hard rock is fed to large gyratory crushers, and the soft ore to disintegrators of a special type. From the crushers horizontal and inclined-belt conveyors collect the ore, elevate it and distribute it over large storage bins. From the bins the ore is fed by gravity directly to a battery of ten rotary kilns. The kilns are 50 feet long and most of them are cylindrical, seven feet in diameter. A few 6-feet cylindrical kilns and a few tapered kilns, six to eight feet and seven to ten feet, are also used. These kilns were once fired mostly by producer gas, but they have been converted to burn pulverized coal exclusively. The temperature used is probably about 1100° F. and the mechanically held moisture is reduced to from one-half of one per cent to one per cent. From the kilns the material drops into a long pan conveyor, where it cools to some extent, and is then elevated into large bins. For shipment the ore is drawn off through chutes into covered, hopper-bottom, standard-gage railway cars of a special type. A part of the ore is dead-burned (for use in abrasives and refractories) in 6x60 feet cylindrical rotary kilns in which a temperature of about 2000° F. is maintained. This burning reduces the total moisture (mechanically and chemically combined) to about one-half of one per cent.

"In other districts various methods of drying have been used. These processes include air drying on racks under sheds; piling ore on a wooden platform and setting fire to the wood; drying on horizontal iron sheets under which flames from a furnace are made to pass; and drying in small, wood- or coal-fired rotary kilns. Some of the simpler methods were inefficient and have been to a large extent abandoned. At the larger operations the small rotary kilns are used, and from ten to fifteen per cent of the mechanically held water is driven off. The flow sheets in such mills are similar to the flow sheets described above, but less elaborate."[99]

Uses of Bauxite

The chief uses of bauxite are (1) in the production of metallic aluminum, (2) in the manufacture of aluminum salts, (3) in the manufacture of abrasives, and (4) in the making of refractories. Most of the ore produced is used

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[99] Ladoo, Raymond B., Bauxite: occurrance, mining, and uses, Eng. Min. Jour. Press, vol. 114, pp. 805-809, 1922.

in the manufacture of the metal aluminum. In some years the amount of ore used in the manufacture of chemicals is greater than that used in abrasives, and in other years vice a versa. That used in refractories has been small; at the present time it is extremely so, this industry being almost completely supplied by bauxitic clay and diaspore clays. The statistics by the U. S. Geological Survey show the approximate consumption of domestic bauxite by the different industries.

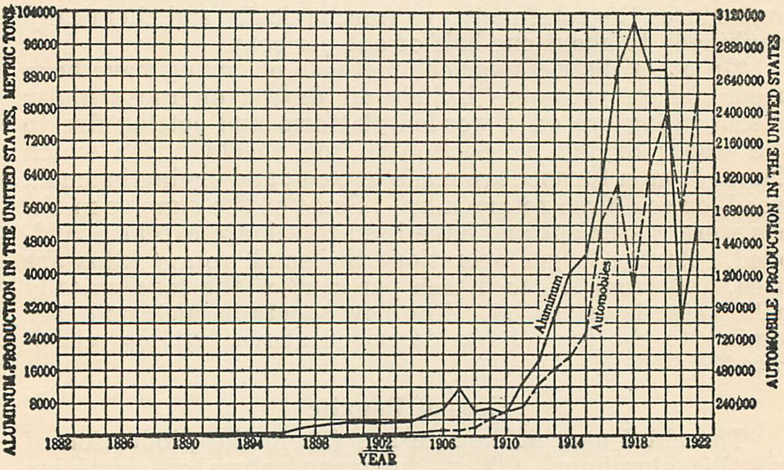
Domestic bauxite consumed by various industries, 1917-1922, in long tons:

	1917	1918	1919	1920	1921	1922
Aluminum	375,000	419,043	272,270	383,154	91,700	211,560
Chemical	82,000	63,896	67,842	85,878	41,000	78.540
Abrasives	100,000	112,908	35,395	*a*52,276	6,850	19,270
Refractory	2,400	9,874	1,059	----	----	230

a. Probably includes a small quantity sold to makers of refractories.

In Aluminum Manufacture

As indicated, from 66 to 74 per cent of the domestic bauxite consumed in the United States in recent years has been in the manufacture of metallic aluminum. The consumption of aluminum has been reflected closely for a number of years in the status of the automotive industry. The following graph shows the relation between the domestic aluminum and automotive outputs:



[100]—Comparative production of aluminium and automobiles in the United States.

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[100] Anderson, Robert J., Aluminum and bauxite, The Mineral Industry, 1922, vol. 31, p. 8, 1923.

The Aluminum Company of America is the sole producer of aluminum in this country and controls the aluminum industry of North America as a result of its control of the Northern Aluminum Company of Canada, and turns out products equivalent to one-half of the world's consumption of this metal. The company also controls the production of bauxite through its subsidiaries, the American Bauxite Company, the Republic Mining and Manufacturing Company, and the Demerara Bauxite Company of British Guiana.

Aluminum manufacture falls into two parts, (1) plates, sheets, rods, wire, and tube, and (2) manufactured articles or wares. About thirty-four companies are engaged in the manufacture of aluminum wares. Rapid as has been the growth in the use of aluminum, there would be even greater consumption if it were available at lower cost. Lack of competition in its production and control of patents and large tonnage of high-grade bauxite has made this impossible in the past. The expiration of many of the patents will probably remove some of the obstacles to the expansion of the industry.

Aluminum production has surpassed that of tin since 1915, and has been about one-fourth that of zinc, one-fourth that of lead, and one-sixth that of copper in recent years. "Richards hazards the thought that lead will be surpassed by 1930 and zinc by 1940 and says that in variety of uses and importance of its functions, aluminum is exceeded probably only by iron and copper."[101]

However, aluminum has some limitations in its uses. The soldering of aluminum is unreliable and considered impossible by some writers, but by actual welding the metal can be made into vessels of any shape and size. Aluminum, though suitable for many purposes, is unable to resist corrosion from hydrochloric acid, halogen solutions, or caustic alkalies. Likewise the metal is slowly attacked by nitric and sulphuric acids, but is superior to most other metals in resisting chemical corrosion. On the other hand, oleic, stearic, and palmitic acids may be stored in aluminum tanks.

Aluminum is replacing copper on electrical transmission lines where it is more economical. The aircraft industry continues to increase its use of aluminum. The demand for aluminum alloys is also constantly increasing. It is also used in thermit welding and in making the high explosive ammonal.

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[101] Maynard, T. Poole, Bauxite and Aluminum. Chem. Age, vol. 30, pp. 86-88, 1922.

Reduction Processes

"The primary intermediate product in the separation of aluminum from bauxite is alumina, the hydrated oxide, prepared by the fusion process described later for the manufacture of aluminum sulphate.

"In the Bayer process the bauxite is first calcined, then finely ground, mixed with caustic soda solution of about 47° Be., and heated for some hours with steam under a pressure of five or six atmospheres, which forms a solution of sodium aluminate. This is then diluted to 24° Be. and filtered rapidly. So prepared, the solution contains about 1 Al_2O_3 to 1.8 Na_2O. This is run into an autoclave, some precipitated alumina stirred in, and the solution agitated for three days, by which time about 70 per cent of the alumina has separated and the solution contains 1 Al_2O_3 to 6 Na_2O. The aluminum hydroxide is then filter pressed and air dried. The solution is again heated with powdered bauxite until its composition corresponds to 1 Al_2O_3 to 1.8 Na_2O and the process repeated. There are a number of modifications of the Bayer process.

"The Serpek process, used primarily for the fixation of nitrogen, has been used to some extent. This method depends upon the formation of aluminum nitride, AlN, by heating bauxite in the presence of carbon and nitrogen at a temperature between 1800° C. and 1900° C. The mixture of bauxite and coal or coke is calcined in a kiln and then heated in another kiln to 1800° C. to 1900° C., where gas, produced by passing air through a gas producer, is forced through the heated mass. This forms aluminum nitride, which, when treated in an autoclave with steam under pressure, is decomposed into ammonia and aluminum hydroxide.

"In the production of 'pig' aluminum by the Hall process of reduction, the alumina is electrolyzed in a bath of fused cryolite or mixed fluorides contained in a carbon-lined vessel the sides of which serve as the cathode, while carbon electrodes immersed in the bath serve as anodes. The alumina is added to the fused bath and undergoes decomposition by electrolysis, the oxygen collecting at the anodes and consuming them with the formation of carbon monoxide, while the metal collects at the bottom and is tapped off as required and moulded into pigs of about 45 pounds each."[102]

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[102] *Loc. cit.*

In the Production of Aluminum Salts

The production of aluminum salts in 1922 was 281,480 short tons valued at $8,812,987. The consumption of materials in the manufacture of the salts was as follows: bauxite 162,976 long tons valued at $2,305,000 and high-alumina clay 11,428 tons valued at $114,280. In 1922 six companies produced 8,305 short tons of ammonium alum valued at $535,759; three companies made 9,506 tons of sodium alum valued at $570,372; five companies made 4,039 tons of aluminum chloride valued at $289,502; nineteen industrial plants made 231,387 tons of commercial aluminum sulphate valued at $6,090,166; nine municipal water purification plants made 6,075 tons of "Hoover" alum valued at $126,095; and seven plants made 19,162 tons of iron free aluminum sulphate valued at $968,645, and other aluminum salts (includes one producer of potash alum and two producers of calcined and hydrated) 3,006 tons valued at $232,448.

Aluminum hydroxide is used principally in the manufacture of other aluminum compounds; also in the preparation of lake colors, in waterproofing fabrics, cement making, and in medicine. No figures are available to show the quantity produced. Colloidal aluminum hydroxide is used in sugar refining.

Aluminum sulphate is used in paper making for the preparation of sizing material, as a mordant for dyeing, for the purification of water, for tanning skins, and for the refining of mineral oils, and for other uses where crude alum was formerly employed. It does not crystallize as well as alum and is therefore not so easily purified.

In the manufacture of aluminum sulphate, "bauxite is ground, mixed with soda ash, and calcined at a white heat. The resulting mass is ground, lixivated with water, filtered, and treated with carbon dioxide. The precipitated hydrate of alumina is then added to hot concentrated sulphuric acid until frothing ceases, after which it is run into crystallizing pans.

"Alum, the double sulphate of alumium and of the metal, usually the alkali metals, or iron or chromium, which gives to the salt its characteristic name, is made from aluminum sulphate obtained as above described and then adding the exact amount of the alkali sulphate to form the desired alum."[103]

Alum is made in Europe and other countries from natural alum rock, alum shales, or alum schists.

Aluminum chloride is used in the refining of mineral oils,

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[103] *Loc. cit.*

for carbonizing wool, and in the manufacture of certain organic compounds.

Aluminum acetate is used as a mordant in calico printing, and dyeing; for the manufacture of lake colors, and in waterproofing and fireproofiing fabrics.

In Making Bauxite Abrasives

Bauxite abrasives are made by fusing bauxite with carbon in an electric furnace, breaking down the fused product, pulverizing, and sizing the grains. If made from pure bauxite the product is practically an artificial corundum. The manufacture of aluminous abrasives to silicon carbide abrasives in this country is about in the ratio of ten to one. Bauxite abrasives are sold under various trade names, such as alundum, adamite, alowalt, aloxite, borocarbone, carbo-alumina, corowalt, corubin, exolon, metalite, oxalumina, rex, and others, in the form of grinding wheels, abrasive papers and cloths, oil stones, and other products. Varying degrees of hardness and toughness in the abrasive may be obtained by using different grades of bauxite.

As a Minor Constituent of High-Alumina Refractories

High-alumina refractories contain from 50 to 76 per cent alumina. They are made chiefly from bauxitic clay and diaspore clay although a small amount of bauxite is used annually. Bauxite bricks are made by mixing calcined bauxite or high-alumina clay with a bonding material such as fireclay, sodium silicate, or lime, shaping by hand or machine, and burning in various types of brick kilns at a high temperature. Another type of aluminous refractories is made by fusing bauxite in an electric furnace and casting the molten material in molds. The demand for this type of refractories is increasing owing to the ever-growing need for better refractories. Pure bauxite melts at about 1820° C. and pure alumina at about 2050° C., but the lower grades of bauxite brick melt at 1740° C. or less. The value of bauxite refractories depends upon their chemical inertness at high temperatures. In basic open-hearth steel practice bauxite brick should probably contain more than 12 per cent silica. Probaly 50,000 tons of clays and diaspore were used in 1922 in the manufacture of aluminous refractories.

Grades of Bauxite Required for Specific Uses

The following grades of bauxite are those usually given in the literature or by companies in the different industries:

Metallic aluminum—

Alumina, Al_2O_3, more than 52 per cent;

Silica, SiO_2, not more than 4.5 per cent;

Iron oxide, Fe_2O_3, not more than 6.5 per cent;
Silica and iron should not be more than 15 per cent.

In the Arkansas field the silica content is high; an attempt is made to maintain a maximum of six to eight per cent silica, but an extreme limit of 12 per cent is sometimes tolerated. European bauxite has a higher iron content and a certain amount (greater than in the United States) is not considered injurious except so far as its presence means a decrease in the alumina content. As a matter of fact fairly low grade bauxite high in silica or iron, or both, is mixed with better ore and used. Producers, of course, prefer bauxite low in iron and silica.

Alum and aluminum sulphate
Alumina, Al_2O_3, more than 52 per cent;
Silica, SiO_2, 5 to 20 per cent;
Iron oxide, Fe_2O_3, less than 2 per cent.

Bauxite low in iron and titanium oxides is preferred, but for some grades of product less pure material is used.

Bauxite abrasives
Alumina, Al_2O_3, 53-57 per cent;
Silica, SiO_2, 7 per cent or less;
Iron oxide, Fe_2O_3, 4 to 5 per cent.

As a matter of fact lower grades of bauxite have been used when the supply of higher grade ore had been exhausted and ores containing proportions of silica and iron greater than are permissable for other uses, can be used for abrasives. Bauxite low in silica is preferred but the iron content is not very objectionable.

High-alumina refractories

Principal requirement seems to be a low iron content. Most refractories are made from bauxitic clay and diaspore at the present time.

BAUXITE RESERVES

Alabama, Georgia, and Tennessee

The production of bauxite has fallen steadily in Alabama for a number of years; and during 1920, 1921, and 1922 the only producer in the state was the Republic Mining and Manufacturing Company. The production in Tennessee also has been on the decline. The combined production of Tennessee and Alabama in 1919 and 1920 was between five and six thousand long tons for each year. The decline in the production of bauxite in the old Paleozoic area of northwest Georgia has been rapid also; but the increased production from the central part of the state has offset this decline and maintained the production of the Appalachian region near its maximum.

Arkansas

The deposits in Arkansas were estimated to contain about 50,000,000 long tons by Hayes in 1900 before any development had taken place. In 1913 after considerable prospecting Mead decided that Hayes' estimate was greatly in excess of the amount of bauxite actually present. " 'Actual mining and prospecting operations have demonstrated that Dr. Hayes' approximate estimates are far in excess of the actual quantities of bauxite,' states John T. Fuller, superintendent of the American Bauxite Company's plant. It is still impossible to estimate with any degree of exactness the quantity of bauxite of merchantable grade in Arkansas, and the lessons learned since Dr. Hayes' estimate was made, have confirmed the opinion that any estimates made on a bauxite deposit based on outcrops, or geological inferences, are highly speculative and dangerous. Based on mining and prospecting operations since 1900, a conservative estimate of the amount of bauxite on the areas listed by Dr. Hayes would place it at one-tenth of Dr. Hayes' figures, or approximately 5,000,000 tons from which must be deducted the bauxite mined since 1900."[104]

Exhaustion

The annual maximum production of a half million tons of bauxite with every possible chance of increase due to the use of its metal derivative, directs attention to the approaching exhaustion of high-grade bauxites considered of commercial grade by the present methods of mining. Bauxites

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[104] Ferguson, Jim G., Outlines of Arkansas geology. Bureau of Mines, Manufactures and Agriculture, p. 48, Little Rock, 1920.

of poorer grade will have to be used in the future to meet the increasing demand.

Uses of Low-grade Bauxite

The perfection of processes for the concentration of the alumina content of low-grade bauxites is of considerable importance in the enhancement of the value of bauxite deposits heretofore not considered of commercial importance because of their alumina content of 52 per cent or less. The following description of the Everhart patents is that of T. Poole Maynard in The Mineral Industry for 1921.

Everhart Patents

"The most important development as a result of research during 1921 is the Everhart process of concentrating low-grade bauxite. The alteration of clays into bauxite ordinarily has been so gradual that the slight distinction in the two materials imposes great difficulty in their separation in the process of concentration. In the study of many bauxitic clays, Dr. Edgar Everhart has demonstrated that this physical difference is sufficiently marked, however, to allow of satisfactory separation by washing in the presence of small amounts of added peptizers. This makes possible the recovery of bauxite from two types of deposits hitherto not considered of commercial interest.

"The first type embraces those deposits carrying granular high-grade ore mixed with varying grades of low-grade ore, where the proportion of clayey impurities varies from as low as 2 to 1 to where the proportion of clay to bauxite is as much as 7 to 1.

"The second type of deposits made available are the low-grade bauxites and bauxitic clays carrying from 42 to 52 per cent alumina, which deposits are not now considered of commercial value, but which can be concentrated to from 55 to 58 per cent alumina, with a loss of clayey impurities varying from 25 to 45 per cent.

"The results of the process on this type of ore are as follows:

	Crude Ore Per cent	Concentrated Ore Per cent
Alumina (Al_2O_3)	48.87	57.85
Silica (SiO_2)	24.39	11.60
Iron oxide (Fe_2O_3)	2.94	1.76
Titanium dioxide (TiO_2)	2.13	2.13

"Bauxite from a wide range of localities has been tried out by this process. The most successful peptizers used are sodium hydroxide and the more strongly absorbed sodium salts. Patents have been granted covering the use of the above materials and process. A curious phenomenon observed in connection with these experiments is that in a few of the highly aluminous clays sulphuric acid, which usually acts as a coagulent, appears in the role of a peptizer in certain low concentrations. Another feature of very great commercial importance is that the iron and titanium oxides contained in the clay substance are not precipitated with the alumina, but are washed out with the clayey impurities. This makes available for the chemical industries as well as for the manufacture of aluminum an ore high in alumina and at the same time very low in iron and titanium.

"The use of the process does not involve any particular type of machinery. It can be adapted to the wide variety of washing and concentrating machinery now on the market. As this process of concentrating bauxite is the converse of the present system of clay washing, the clays can very readily be recovered in the refined condition and used in suitable by-products. Extensive tests have shown that this method of concentration can be applied with success to a wide variety of low-grade bauxites in the three great fields in this country. While certain indurated and more silicious ores are not susceptible to treatment, there remains a broad field of application.

"The application of these methods can make possible the use of mechanical equipment in mines, save much of the wasted overburden, and make commercial many of the underlying bauxitic clays, thereby making available immense deposits so low in alumina that they have never been opened."

Mississippi

The bauxite deposits of Mississippi, although many of them are not as high-grade as those in Arkansas and the Appalachian Valley region, seem to have considerable future. The deposits which have been prospected are estimated to contain 403,000 tons of bauxite, 40 to 60 per cent Al_2O_3 and 145,000 tons of bauxite 50 to 60 per cent Al_2O_3. All the ore can be dried, thus increasing the relative quantity of aluminum oxide, Al_2O_3, about 10 per cent and some of the ore can be washed, thus improving its quality materially. The possibility of concentrating low-grade bauxite by the Everhart method or some similar method and the accessibility of the deposits to the hydroelectric power in prospect at Muscle Shoals are the dominant potentialities.

The results of the prospecting and the continuity of the beds of bauxite indicate that the percentage of "clay horses", which have to be wasted, is much less in Mississippi than it is in the fields of Arkansas or Georgia. The bauxite lies near the tops of the hills, ridges, and spur ridges; and many of them seem to have been held up by the hard resistant cap of bauxite ore. Consequently, the overburden is, in general, less than ten feet and, in many places (e. g. Big Hill), less than five feet, and never reaches a maximum of twenty-five feet. This is in decided contrast to the deposits in the Appalachian Valley region and to those in Arkansas, where a maximum overburden of 140 feet is reached.

The deposits which have been prospected are estimated to contain more than 1,000,000 tons of low-grade material; as well as, 403,000 tons of bauxite, 40 to 60 per cent Al_2O_3, and 145,000 tons of bauxite, 50 to 60 per cent Al_2O_3. All this ore can be dried, thus increasing the relative quantity of aluminum oxide, Al_2O_3, about 10 per cent, and some of the bauxite can be washed thus improving its quality materially. This will make available an additional 300,000 to 400,000 tons of ore containing more than 40 per cent Al_2O_3. As the known deposits and surface showings are scattered throughout an area of thousands of acres, there is little doubt that further prospecting would show still other deposits. The possibility of finding additional large deposits of bauxitic clay is good. From the exceptionally large scaled topographic maps (32 inches=1 mile) the areas of the deposits have been carefully figured and the grade of bauxite used in making estimates is that of the ore found in the test pits.

The possibility of concentrating low-grade bauxite by the Everhart method or some similar method, and the accessibility of the deposits to the hydroelectric power in prospect at Muscle Shoals are the dominant potentialities.

APPENDIX

METHODS OF CHEMICAL ANALYSES OF BAUXITE

GENERAL STATEMENT

In the chemical analysis of bauxite the method employed depends on the use for which the bauxite is intended.

In the aluminum industry the Tri-acid Method is generally used. The amount of soluble alumina, Al_2O_3, is obtained by this method. The tri-acid solvent mixture is a solution of concentrated sulphuric, nitric, and hydrochloric acids, and of water. Another method sometimes used is a slight modification of the first.

In the chemical industry the Ferguson and the so-called National Method are used by companies manufacturing aluminum salts. The chief point of the methods is the digestion of the bauxite with sulphuric acid of 50° Baume concentration.

Still another method, which permits of the complete analysis of the sample, might be called the carbonate of soda fusion method. Its limitations are discussed under the method itself.

TRI-ACID METHOD OF ANALYSIS

Solvent

The solvent mixture is made up in the following way:

200 cc. of concentrated sulphuric acid;
100 cc. of concentrated nitric acid;
300 cc. of concentrated hydrochloric acid;
400 cc. of water.

The sulphuric acid and the water are mixed and cooled and the nitric acid and the hydrochloric acid are then added.

Preparation of Solution

Two and one-half grams of a sample previously dried for one hour at 150° are weighed out and transferred to 650 cc. Pyrex Kjeldahl digestion flask. One hundred and fifty cc. of the tri-acid mixture are added; and the digestion is carried out in the usual way. The boiling should be continued for at least 40 minutes after dense white fumes begin to come off. Now 50 cc. of 1 to 1 sulphuric acid are added; and the contents of the flask boiled for 15 minutes. Add 150 cc. of water, boil for 15 minutes, filter, and wash up to a volume of 500 cc.

Determination of Silica

The residue on the paper is burned wet and heated over a blast lamp to constant weight. The contents of the crucible is then treated with several portions of hydrofluoric acid. The residue is reheated before the blast, and the silica volatilized is represented by the difference between the two weights.

Determination of Iron Oxide

One hundred cc. are reduced in zinc, and the iron estimated by titration with standard potassium permanganate. The permanganate equivalent of the titanium dioxide is subtracted, and the percentage of iron is computed in the usual manner.

Determination of Aluminum Oxide

An aliquot of 100 cc. of the solution representing one-half gram of bauxite is diluted to 150 cc. made faintly alkaline, boiled, and filtered hot; and the mixture of iron and aluminum oxides is weighed. The percentage of iron previously found by the volumetric process is deducted, the remainder being the content of aluminum oxide. The mixture of iron and aluminum oxides may be fused with potassium acid sulphate and the melt dissolved and the iron determined volumetrically as usual.

Determination of Titanium Dioxide

For the small amount of titanium usually present in bauxites, the colorimetric method gives satisfactory results.

Use an aliquot of 25 cc. Add five cc. of hydrogen peroxide and five cc. of sulphuric acid; bring to a volume of 100 cc. in a Nessler jar. Match the color produced with a set of titanium standards.

TRI-ACID METHOD OF ANALYSIS—II

The sample is run through a mill, quartered, and prepared through a 60-mesh screen. It is then dried at a temperature of 100-105 C.

One gram is digested with the tri-acid mixture, consisting of:

12 parts H_2SO_4, 1:3 mixture;
6 parts strong HCl;
2 parts HNO_3.

Silica

Use 90 cc. of the mixture to one gram, to which add an additional 10 cc. of concentrated H_2SO_4; heat to fumes, and dilute with water and filter. Ignite the residue and fuse the ash with potassium bisulphate; take up the cooled fusion mixture with 5 cc. of sulphuric acid and 20 cc. of water, and digest until white residue remains, filter, wash, and ignite. This gives the amount of SiO_2 present.

Aluminum and Iron Oxides

Add ammonia, not in too great excess to filtrate from tri-acid digestion, heat moderately, filter, and wash free from ammonia with hot water, dry and ignite the filter residue. The results are the Al_2O_3 and Fe_2O_3.

Iron

Digest two grams of ore with HCl and water, cool, add water, and oxidize with 60 cc. of saturated solution of mercury bichloride; titrate with approximately n/10 di-chromate solution (standardize di-chromate against iron wire) using a vitrolite plate, and for a titration indicator, potassium ferricyanide, titrate until no blue appears after 30 seconds.

Titanium

The titanium is estimated by a colorimeter, using 0.1 gram of ore sample.

Loss on Ignition

Loss on ignition is determined by burning to redness about 45 minutes.

FERGUSON METHOD OF ANALYSIS

Preparation of Sample and Solution

A quantity of bauxite is ground to pass through a 100-mesh sieve and dried in the oven over night at 100° C.

Five grams are weighed up and placed in a 300 cc. Kjeldahl flask, fitted tight to an upright condenser.

Fifty-four grams of 20% H_2SO_4 are added to the flask and the flask is immediately connected to the condenser, and contents digested for exactly three hours from time of adding acid. The volume in the flask should remain constant during digestion.

At the end of three hours remove the flame. The condenser should be rinsed down into the flask. Remove the flask and wash off the stopper, and filter the contents of the flask immediately through an ashless filter paper, using hot water to wash out the flask thoroughly. Continue washing the residue on filter with hot water until the filtrate amounts to about 500 or 600 cc. Cool and make filtrate up to one liter.

Insoluble Matter

The filter paper with the insoluble residue is placed in a weighed platinum crucible and dried; ignite over a low flame until paper is consumed, then blast for at least fifteen minutes and weigh as insoluble.

Iron and Aluminum Oxides

The filtrate being made up to one liter, 50 cc. are then placed into a tall beaker, made up to about 200 cc. Add 10 cc. HCl, bring to boil, and add ammonium hydroxide, being careful to get only about two drops in excess, using methol orange as indicator. Let stand until the precipitate has collected and filter through an ashless filter paper. Wash thoroughly with hot water. When drained thoroughly, place in a weighed platinum crucible, dry in an oven and ignite at low temperature until the paper is consumed; then blast for at least fifteen minutes, cool in dessicator and weigh. This is the combined oxides of iron and soluble alumina.

Iron Oxide

For iron determination, take 100 cc. of the filtrate and place it in an 800 cc. boiling flask. Add five or six drops of a concentrated solution of potassium permanganate, set on flame and bring to boil, remove and add 10 cc. hydrochloric acid and a few drops of a solution of stannous chloride (made up according to A), or enough to make the solution white, dilute with cold water immediately, and cool. When cool add 5 cc. of a solution of mercuric chloride (made up according to B) and titrate with a standard solution of potassium permanganate (made up according to C), using 10 cc. of a titrating solution (made up according to D), and about 500 cc. cold water.

The percentage of iron oxide found subtracted from the combined iron and alumina oxides gives the soluble alumina.

Reagents

A—Stannous chloride solution

Forty-five grams of concentrated HCl, boiled with a few pieces of pure tin. The solution is diluted to 450 cc. Not more than this bulk of the solution should be made up at a time, as it deteriorates. A few pieces of pure granular tin should be kept in this solution.

B—Mercuric chloride solution

This contains 50 grams of mercuric chloride per liter distilled water. Make up only one liter at a time.

C—Potassium permanganate solution

This solution contains one gram of potassium permanganate per liter and is standardized against ammonia-iron alum.

D—Manganese sulphate solution

The titrating solution consists of 100 grams of manganese sulphate dissolved in water and made up to 1800 cc.; to this add 300 grams of glacial phosphoric acid and then 350 cc. of concentrated H_2SO_4, gradually with shaking.

NATIONAL METHOD OF ANALYSIS

Moisture

Dry 100 grams of unground bauxite for three hours at 140° C. The loss in weight equals the percentage of moisture.

Hydrate water

Weigh 2 grams of bauxite (which has been ground to 100-mesh and dried) into a weighed platinum crucible. Ignite for 30 minutes in a blast lamp or an electric furnace. Weigh and blast for a few minutes longer. Cool and weigh again. The loss in weight when a constant weight is obtained is hydrate water.

$$\frac{\text{Loss in weight x 100}}{2.0} = \text{percentage of hydrate water}$$

Insoluble

Weigh two grams of 100-mesh, dried bauxite into a 250 cc. Erlenmeyer flask, fitted with air condenser. Add 20 cc. of exactly 50° H_2SO_4 and keep at the boiling point for three hours, taking care that all water is condensed by the air condenser and none escapes. Cool a little. Add 25 or 30 cc. of water and filter through an ashless filter into a 250 cc. vol. flask. Wash, filter several times with hot water. Ignite and weigh as insoluble.

$$\frac{\text{Weight insoluble x 100}}{2.0} = \text{percentage of insoluble}$$

Soluble Al_2O_3

Make the filtrate from the insoluble up to exactly 250 cc. Place 50 cc. in a 250 cc. beaker, add a little bromine water, and boil to expel excess bromine. Add 10 cc. concentrated HCl and make slightly alkaline with NH_4OH. Boil off excess of NH_4OH. Wash several times by decantation, decanting through a filter. Filter and wash with hot water. Ignite and weigh as Al_2O_3 plus Fe_2O_3. Subtract the percentage of Fe_2O_3 from the percentage of Al_2O_3 plus Fe_2O_3 and result is soluble Al_2O_3.

$$\frac{\text{Weight } Fe_2O_3Al_2O_3 \text{ x 100}}{0.4} = \text{percentage of } Al_2O_3Fe_2O_3 \quad \text{—}Fe_2O_3 = \text{percentage of } Al_2O_3$$

Soluble Iron as Fe_2O_3

Make colormetric test exactly as with alum, using 1 cc. of soluble from the 250 cc. flask.

$$\frac{\text{No. cc. standard } Fe_2O_3 \text{ solution used}}{0.8} = \text{percentage of } Fe_2O_3$$

or 100 cc. of solution may be taken, reduced with stannous chloride, a little $HgCl_2$ added, and the reduced iron titrated with n/2 $KMNO_4$.

THE CARBONATE OF SODA FUSION METHOD

Edgar Everhart, Acting Chemist of the Geological Survey of Georgia, states that in making bauxite analyses for that survey, the samples are fused in sodium carbonate and that the melt is dissolved in the usual way in dilute hydrochloric acid. Two evaporations are made for the complete dehydration of the silicic acid. It is obvious that the fusion method permits of the complete analysis of the sample. It is also true that the method is of no value in distinguishing between bauxitic alumina and alumina present in the form of silicates.

METHODS USED

It may be added that, according to information furnished the writer, the tri-acid method is followed in the chemical laboratories of the Aluminum Company of America.

It should be stated too, that all the chemical analyses of the Mississippi bauxites have been carried out by the use of the so-called tri-acid method. The samples were not dried, however, before being sent to the chemical laboratory, though it is evident that in practice, the drying of the ore will materially decrease its weight and effect a corresponding increase in the proportion of the alumina.

ANALYSIS OF DIASPORE

"It was observed that the usual standard method for analyzing clay was not entirely satisfactory for analyzing diaspore. This material is difficult to fuse with sodium carbonate and often considerable alumina remains with the silica residue. The carbonate fusion was, therefore, dissolved in hydrochloric acid and the insoluble residue filtered off. This residue and paper were then ignited and fused with potassium bisulfate. This cake was added to the original filtrate and the silica determined in the usual manner, care being exercised to correct the silica with hydrofluoric acid.

"While the precautions involve considerable extra care and time they are deemed necessary, since the chief difference in the composition of clay and diaspore lies in their silica contents."*

M. H. Thornberry has worked out a method for the analysis of diaspore clay by fusing it in a nickel crucible with sodium hydroxide.

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*Howe, Raymond M. and Ferguson, R. F., Composition and properties of diaspore, bauxite, and gibbsite: Jour., Am. Ceramic Society, vol. 6, No. 3, p. 498, March, 1923.

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