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*Virginia-Louisiana Purchase
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A Hand Book
on the
Minerals and Mineral Resources
of Virginia



Prepared for the Virginia Commission
to the St. Louis Exposition



by
Froehling & Robertson,
Chemists and Economic Geologists,
Richmond, Virginia.

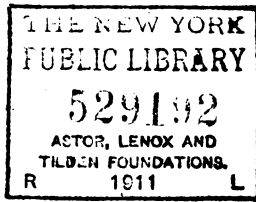
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PREFACE.

The object of this hand book is to present in convenient and concise form a complete list of the minerals occurring in Virginia, together with a description of the various deposits of ores and minerals, and the present state of development of same.

In its preparation all existing available publications have been freely used, supplementing extended personal investigation of the different mining enterprises and partially developed deposits.

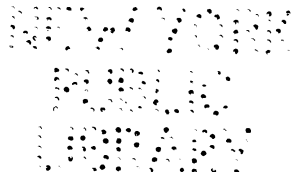
Alphabetical arrangement of the various subjects has been followed throughout, and mineralogical descriptions of the different minerals have been included in the hope that such will make the book more useful.

Among the publications made use of should be mentioned "The Minerals and Mineral Localities of Texas" which has been closely followed in the matter of arrangement; Dana's "Mineralogy" (New Edition); Prof. Roger's "Geology of the Virginias;" Prof. A. S. McCreath's "Mineral Wealth of Virginia;" the Transactions of the American Society of Mining Engineers; the various bulletins and reports of the United States Geological Survey; and in the section on Mineral Waters and Spring Resorts, Walton's "Mineral Springs of the United States and Canada;" and Crook's "Mineral Waters and their Therapeutic Uses."

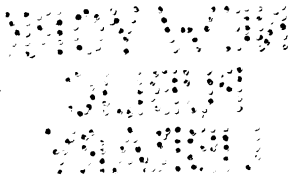
The analyses quoted of mineral waters are the latest available.

RICHMOND, VIRGINIA,

1904.



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Salem, Virginia.



INTRODUCTION.

It is necessary for a thorough appreciation of the extent and variety of the mineral resources—many of which only await capital and enterprise to become remuneratively productive, that some general knowledge be had of the geological formations occurring in this State.

Geographically, Virginia is divided into six natural divisions known respectively as: Tidewater, Middle, Piedmont, Blue Ridge, Valley, and Appalachia. These divisions succeed each other in nearly parallel belts running from the coast to the western State line, and are suggested by the geological divisions to which they closely correspond. It will therefore suffice for a general idea of the geology of the State, to take the geographical divisions above mentioned, and note the geological formations and the chief minerals found in each.

TIDEWATER: This region includes the eastern and southeastern part of the State, and extends west to a line running from Acquia Creek on the Potomac, skirting Fredericksburg, Richmond, and Petersburg, through Em poria to the North Carolina line. Within this area the geological formations found are the Quaternary or Post-Tertiary, the Upper Tertiary or Pliocene, the Middle Tertiary or Miocene, and the Lower Tertiary or Eocene.

The Quaternary or Post-Tertiary is the sandy shore of the Atlantic and bay, and is made up entirely of sand and small gravel.

The Upper Tertiary or Pliocene is the first terrace above the Ocean, and is composed of light colored sand and clays. It covers a large part of the Eastern Shore, and contains some clays suitable for brick making.

The Middle Tertiary or Miocene—the next step westward, extends from the western border of the preceding formation to a line running north and south, a little west of the 77 degrees meri-

dian. This formation is characterized by beds of yellow and blue marl. The yellow variety is the richer of the two, containing as high as 87 per cent. Carbonate of Lime. At some points the beds are of great thickness and these localities present good opportunities for the manufacture of Portland Cement on tidewater.

The Lower Tertiary or Eocene constitutes the surface of the narrow strip of country extending from the western boundary of the Middle Tertiary to the head of tidewater. This formation is composed of beds of clay of various kinds, and the characteristic "green sand marl." This marl owes its green color and its high value as a fertilizer to the presence of a green Potash mineral named "Glauconite." The marl and brick and pottery clays constitute the only valuable minerals found in this formation.

MIDDLE VIRGINIA: This region is a great undulating plain which gently rises from the limit of tidewater to its western boundary—the low, broken ranges of hills forming the outliers of the Blue Ridge, and stretches from the Potomac at the northern part of Fairfax County, to the North Carolina line in the southwest corner of Pittsylvania County.

The rocks found in this region are chiefly of the Azoic or Primary formation, with several enclosed areas or basins covered by or filled with the Triassic and Jurassic or New Red Sandstone rocks.

This great area of crystalline rocks contains many of the most important minerals and ore deposits in the State. The list includes granite—the best of which is the fine biotite variety extensively quarried around Richmond, gneiss of various kinds, slate, steatite or soapstone, mica and accompanying minerals, serpentine, asbestos, limestone, copper, iron and manganese ores, and gold.

Copper ores are found in well defined veins in Buckingham, Prince Edward, Charlotte and Halifax Counties, while extensive beds of hematite iron ores and contiguous ledges of limestone are exposed along the James River Valley.

Gold occurs associated with pyrite, galena and other sulphur-

ets, in quartz veins, over a large part of the area of crystalline rocks.

Of the several isolated areas of the Triassic and Jurassic formations already mentioned as occurring within the region of Primary rocks, the most important is that lying in Chesterfield, Goochland, Powhatan, and Henrico Counties, and constituting the "Richmond Coal Field." This area is underlaid with valuable beds of bituminous coal.

Thin seams of coal have also been found along the edges of similar basins known as the Farmville and Danville areas.

The rocks of the Triassic and Jurassic formations are sedimentary, i. e.: are composed of particles of sand and other rocks deposited in their present position by water, and include some fine sandstones suitable for building purposes. The well known Manassas "Brownstone" is from this formation.

PIEDMONT VIRGINIA: This is the belt of country stretching from the western boundary of Middle Virginia to the eastern base of the Blue Ridge. The rocks of the region are Primary or Azoic, like those of Middle Virginia, but present many different characteristics from those of the more easterly section. They consist of chloritic and talcose gneisses and slates, with much hornblende, and epidotic or greenstone rocks are conspicuous in places.

Within this region the minerals of value are roofing slates, soapstone, asbestos, limestone and iron ore.

THE BLUE RIDGE: The rocks of the eastern flank and summit of the ridge are still Primary, but the epidotic character noticed in those of some parts of the Piedmont section, is much more pronounced, and gives the rocks of this region special peculiarities.

The minerals occurring are epidotic and syenitic granite for building purposes, sandstones and slates. In this region are also located the tin ore deposits of Rockbridge and Nelson Counties, and the copper deposits which have been developed to some extent in Warren County.

On the western flank of the ridge, the rocks belong to the Cambrian formation, and are composed of the Primal or Potsdam sandstone, a close-grained white or light colored stone, and beds of slate and shale.

The formation yields very large quantities of excellent brown and red hematite iron ore, and at numerous points along the western base of the ridge, deposits of high grade manganese ore occur, the best known of which is that at Crimora, Augusta County.

THE VALLEY: This is the great belt of limestone land lying between the Blue Ridge and the various broken ranges of mountains running parallel to it. It extends from the Potomac to the Tennessee line—a distance of more than 300 miles, and includes some of the richest and most beautiful country in the State.

Geologically, the region is that of the Cambrian and Lower Silurian rocks, composed of slates and limestones. These rocks are very rich in valuable minerals including great deposits of red and brown hematite iron ores, and the important zinc and lead ores of Wythe and Pulaski Counties. A great variety of limestone occurs. Some deposits have the characteristics of statuary marble; others of great purity, yield on burning, a building or agricultural lime of the highest grade, while at several points in the Shenandoah Valley, great beds of argillaceous limestone occur, which constitute a Portland Cement rock equal to that of the Lehigh Valley.

APPALACHIA: This region extends west from the Valley to the State line, and is traversed throughout by the mountain ranges of the Appalachian System.

It is thus broken up into a succession of high ridges and narrow valleys, and all the formations from the Lower Silurian to the Carboniferous are exposed at various points.

On the eastern edge of the region—the mountains forming the western boundary of the Valley, the rocks belong chiefly to the Upper Silurian and Devonian formations. (Rogers Nos. IV to IX inclusive.) The Upper Silurian rocks are sandstones, red

shales, and limestones, and in the shales occur important beds of red "fossil" iron ore, while the overlying limestone constitutes a valuable flux. The Devonian rocks exposed include the Oriskany Sandstone, Vergent Shales, and Old Red Sandstone. In the Oriskany Sandstone lie great deposits of brown hematite iron ore, which constitute the chief source of supply for the blast furnaces at Lowmoor and Longdale.

Exposures of the Sub-carboniferous rocks (Rogers X and XI) are found in narrow belts along the southeast flanks of North Mountains. These rocks are the Pocono or Vespertine Sandstone, and overlying the sandstone, the Umbral Red Shales. In the Sandstone many fine beds occur, yielding excellent stone for millstones, grindstones and general building purposes, and just at the top of this formation lie the important anthracite coal deposits of Montgomery, Pulaski, and Wythe Counties. The Umbral shales and sub-carboniferous limestone of the same formation are the accompanying rocks of the great gypsum and rock salt deposits of the Holston Valley in Smyth County.

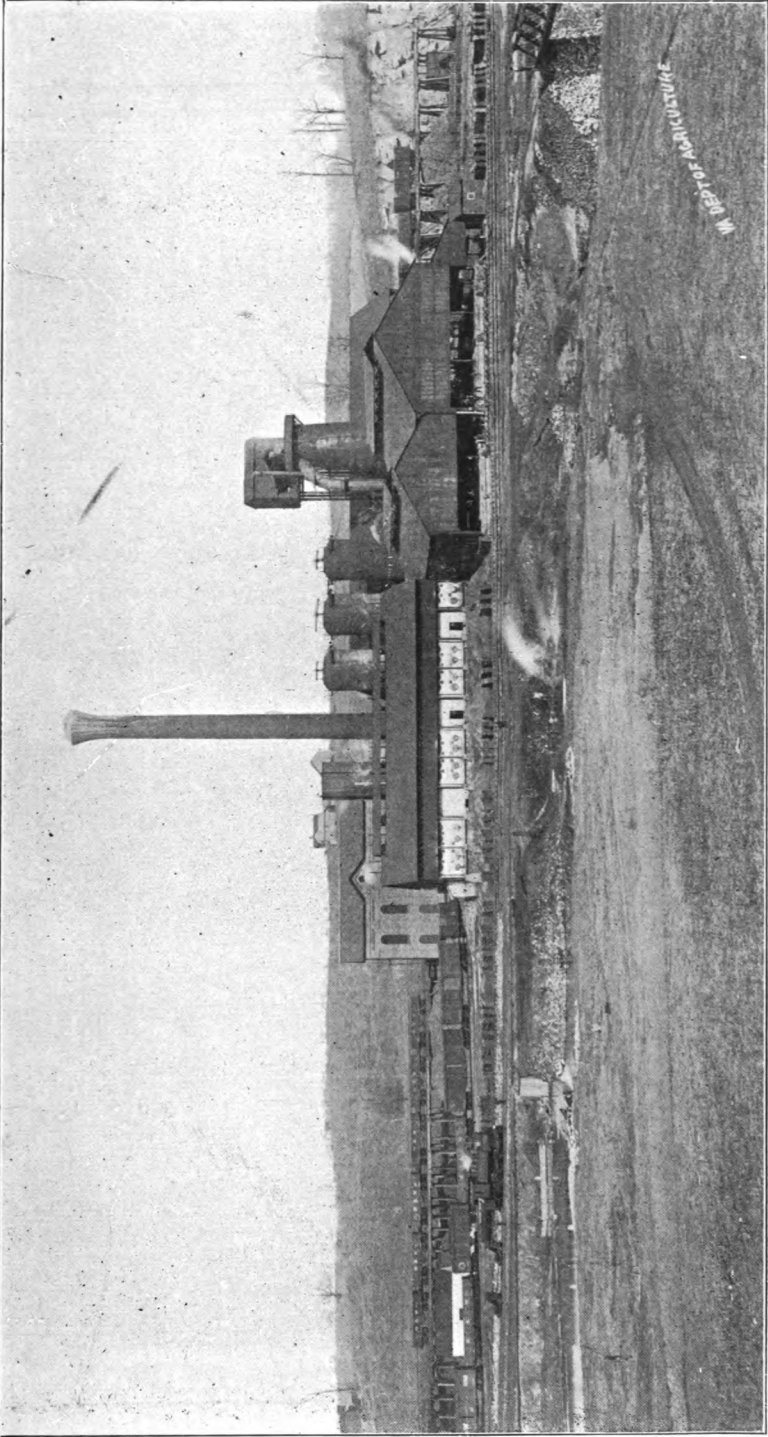
Formations XII to XV of Rogers—the Carboniferous or true coal bearing rocks, are exposed over more than 1,000 square miles in the southwest counties of the State. These formations are made up of sandstones, slates, and seams of the finest bituminous coal.

In accessibility, number of the seams and quality of the coal, the coal fields of the Pocahontas or Flat Top region in Tazewell County, the Clinch Valley and Big Stone Gap districts in Lee and Wise Counties, stand unequalled.

Enough has been indicated in the above sketch of the geological and mineralogical features of the State to show the possibilities of varied and profitable development of mining enterprises. The general conditions are most favorable. The climate permits active operations all the year round, labor is cheap, water abundant, and outside markets are readily accessible.

Particulars of the various ores and other deposits will be found under their respective headings, in the following pages, but

attention may be drawn here to the excellent prospects of remunerative returns on capital invested in the fuller development of the copper deposits, in the careful working by modern methods of many of the larger ore bodies in the gold field, in the reopening of the Richmond coal field, in the development of the deposits, as yet practically untouched, of the finer qualities of clay, and in the manufacture of Portland Cement from the cement rock of the Shenandoah Valley, and from the marls and clays of tidewater Virginia.



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Minerals and Mineral Resources of Virginia.

ACTINOLITE: *Calcium-magnesium-iron, Amphibole, Ca(MgFe)₃(SiO₄)₃.*

Specific Gravity, 3-3.2. Hardness, 5-6. Streak, uncolored. A light green mineral occurring in fibrous, columnar, bladed or granular massive form. Long slender crystals of a rich green color are found in the micaceous gneiss at the foot of Willis' Mountain, Buckingham County. Fine radiated olive-green crystals are also found in the gneiss footwall of the mica mine near Hewlett's Station, Hanover County, and at Taylorstown, Loudoun County.

AGATE: *Variegated Chalcedony.*

The colors are distributed either in straight, wavy or circular bands, in clouds, or in spots due to visible impurities. Agates varying in size from 9 inches to 3 inches in diameter, are found in considerable quantity, at Point Pleasant on north side of Walker's Mountain, Bland County, and at several other points in Giles and Montgomery Counties.

ALABASTER: *See Gypsum.*

ALBITE: *Soda Feldspar, Aluminum-sodium Silicate. Na₂O. Al₂O₃. 6 SiO₂.*

Specific Gravity, 2.62. Hardness, 6-6.5. Triclinic. Color, white, occasionally light bluish white, gray or green, opalescent. Occurs in the old Rutherford Mica Mine near Amelia Courthouse from which beautiful specimens have been taken; also in the Mica Mine near Hewlett's Station, Hanover County.

ALLANITE: *Orthite: A Silicate of Aluminum, Calcium, Iron, Cerium, Lanthanum, and other rare earths.*

It is a brownish black, brittle mineral, with a sub-metallic or

2 MINERALS AND MINERAL RESOURCES OF VIRGINIA.

resinous lustre, occurring in tabular, or elongated crystals; also massive and in grains. Hardness, 5.5-6. Specific Gravity, 3-4.2. It has been found in the massive form at Fabers' Mills, Amherst County, and in the Rutherford Mica Mine, Amelia County.

ALAMANDITE: *Iron-aluminum Garnet. See Garnet.*

ALUM SHALE: Large quantities of alum shale are found in Rockbridge, Bath, Bedford and Washington Counties, and are the source of the well known Alum Springs occurring in these localities. On Jackson River, in Bath County, the celebrated "Alum Rock" consists entirely of alum shale, and presents an interesting appearance, thus described by Rogers:

"It rises in an abrupt and lofty cliff, forming a semicircle at the bend of the river, and presenting a scene which is at once curious and imposing. Over the surface of the wall-like precipice, streaks and stains arising from the copperas or ferruginous matter of the rock, and of the size of a bomb, lie here and there imbedded in the mass."

ALUM EARTH: In the Green Sand Marl deposits along the James and Pamunkey Rivers, occasional beds are found containing masses of crystals of sulphate of iron and alumina imbedded in clay. At the Evergreen farm, about 1½ miles below City Point on the James River, such a deposit is to be seen.

AMAZON STONE: *Green variety of Orthoclase. Potash Feldspar.*

Specific Gravity, 2.56. Hardness, 6.3. Color, light green or bluish green, the cleavage faces having vitreous to pearly lustre. Large quantities of this mineral were obtained from the mica mine near Amelia Courthouse, when the mine was in operation.

AMETHYST: *Amethystine Quartz. A violet variety of quartz.*

Specific Gravity, 2.66. Hardness, 7. Found in Nelson County, Albemarle County and Buckingham County, near Willis' Mountain. Beautiful samples have also been obtained from the Mica Mines of Amelia County.

AMIANTHUS: *Fine silky variety of asbestos. See Asbestos.*

AMPHIBOLE: *Hornblende. Magnesium-calcium-iron-aluminum Silicate.*

Color, varies from dark green to black. Specific Gravity, 2.9-3.4. Hardness, 5-6. This mineral is found very abundantly in the granite rocks and schists of Virginia.

ANDRADITE: *Calcium-iron Garnet, 3 CaO Fe₂O₃ 3 SiO₂. See Garnet.*

APATITE: *Calcium Phosphate.*

Occurs in various forms—hexagonal prisms, and in fibrous masses; also massive granular. Color, white, yellow, gray, green and blue. Specific Gravity, 3.2. Hardness, 5. In Amelia County, near Amelia Courthouse, it has been found in translucent white crystals.

A large deposit of Apatite, mixed with Magnetic Iron Oxide, exists in the vicinity of Lovingsston, Nelson County, but so far no profitable use has been made of it.

ARAGONITE: *Calcium Carbonate, CaCO₃.*

Specific Gravity, 2.93. Hardness, 3.7. Color, yellow, yellowish white and yellow brown. Shape, columnar, fibrous, stalactitic, banded, massive.

Composition of a sample from Murat, Rockbridge County:

Silica	0.10 per cent.
Calcium Carbonate	98.10 " "
Magnesium Carbonate .....	.83 " "
Alumina ..	.82 " "
Ferric Oxide	
	99.85 " "

Prof. F. C. Dunnington (Metallurgical Review, May 1879), reports on a peculiar sample from Wythe County, as follows:

Lime (CaO).....	51.819 per cent.
Lead Oxide (Pb O)	6.087 " "
Carbon Dioxide Oxide (CO ₂)	41.800 " "
Ferric Oxide (F ₂ O ₃).....	.033 " "
Silica (Si O ₂).....	.012 " "
Water (H ₂ O)070 " "
	99.821 " "

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ARSENO-PYRITE: *Mispickel Arsenical Iron Pyrites*, Fe S_2 ,
 Fe As_2 .

Composition, Arsenic, 46 per cent. Sulphur, 19.7 per cent. Iron, 34.3 per cent. Specific Gravity, 5.9-6.2. Hardness, 5.5-6.0. Occurs as prismatic crystals, or in compact massive form. Color, silver-white to steel-gray. Streak, grayish-black. Metallic lustre. Very brittle.

This mineral is found in small quantities in many of the crystalline rocks of the State, and is a frequent constituent of the auriferous sulphurets of the gold belt.

It is found in considerable quantity in a mica schist occurring in Floyd County, near Ferris' Ford, and a plant has recently been established at that point by the United States Arsenic Mines Company, for the production of white Arsenic from this rock.

ASBESTUS: *One of the varieties of Amphibole.*

Occurs in slender easily separable fibres of a white, green or brown color, and is the amphibole variety of the commercial article, Asbestos. It occurs quite extensively in pockets, and also in well defined veins, throughout the granitic and schistose rocks of the State. Though much less valuable than the chrysotile variety of Asbestos, it is easily mined and prepared for market, and for all purposes where the strength of the fibre is not essential, such as in the manufacture of fireproof safes, paints, wall plasters, boiler coverings, etc., it can equally well take the place of the rarer and more expensive chrysotile variety.

There are several localities in Virginia where amphibole Asbestos is being mined and prepared for market. Near Chestnut-fork postoffice, in Bedford County, a number of veins and seams from 8 to 50 inches thick have been opened up. A considerable amount is also found in pockets in soapstone about two miles east of Rocky Mount, Franklin County. The quality of the latter deposit is excellent, the color being beautifully white, and the fibre long and silky. Other localities in which Asbestos has been found are:

On land of United States Mineral Company, Whitehall, Buckingham County.

At foot of Willis' Mountain, Buckingham County.

Chula, Amelia County.

Near Appomattox River, Amelia County.

On Little River, Wythe County.

At Barton's and Singer's, Floyd County.

Near Northern Copper Lode, Grayson County.

Barnett's Mills, Fauquier County.

Near Maidens, Goochland County.

AZURITE: *Blue Copper Carbonate, Hydrous Copper Carbonate,*
 $3 \text{ Cu O, } 2 \text{ CO}_2, \text{ H}_2\text{O}.$

Specific Gravity, 3.83. Hardness, 3.5-4. Color, deep blue, azure blue, Berlin blue. Monoclinic. Occurs in modified rhombic prisms; also massive; often earthy. Found in nearly all the surface workings of the Virginia Copper Mines. See *Copper Ores.*

BARITE: *Barytes, Barium Sulphate, Heavy Spar.,* $\text{Ba S O}_4.$

Specific Gravity, 4.3-4.486. Hardness, 2.5-3.5 Brittle. Color, usually white or yellowish white, but sometimes tinged red, blue or brown. Lustre, vitreous or pearly. Transparent or translucent. Crystallizes in tabular or prismatic forms. The massive varieties are frequently lamellar. Also found fibrous, granular, and compact.

Barytes is found and has been mined in various parts of Virginia. The greater part of the mineral mined has been obtained from Campbell, Pittsylvania, Bedford, Tazewell, Smythe, Bland and Russell Counties. The production in Virginia in 1902 was 17,400 tons.

The following are the principal localities where deposits are found:

Campbell County—Evington, several localities near and on Beaver Creek, near Lynchburg.

Bedford County—Bore Auger Mountain.

Tazewell County—Richlands.

Pittsylvania County—Pittsville Postoffice.

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Botetourt County—Near Buchanan.

Smythe County—Marion.

Washington County—Glade Springs.

Russell County—Along Clinch River.

Wythe County—Wytheville, Brown Hill—in large masses.

Bland County.

Rockbridge County—Near Brownsburg, Buffalo Mills, near Lexington.

Nelson County.

Buckingham County—Eldrige's Mines.

Amherst County.

Orange County.

Warren County—Riverton.

Fauquier County—Near Marshall and Upperville.

Frederick County—Near Winchester.

BAUXITE: *Hydrous Aluminum Oxide*, $\text{Al}_2\text{O}_3, 2\text{H}_2\text{O}$.

Specific Gravity, 2.55. Structure, clay-like, massive, oolitic. In color, the purest variety is whitish or grey-yellow, but the presence of iron produces various shades of brown. Samples of very pure bauxite have been reported from Henry County.

BERYL: *Aluminum-beryllium Silicate*, $3\text{BeO}, \text{Al}_2\text{O}_3, 6\text{SiO}_2$.

Specific Gravity, 2.6-2.8 Brittle. Vitreous lustre. Hexagonal prisms. Color, emerald green, pale blue, yellow and white. Beautiful crystals of Beryl with perfect terminals have been found in the Rutherford Mica Mine, near Amelia Courthouse.

BIOTITE: *A Magnesium-iron Mica. See Mica.*

BORNITE: *Purple Copper Ore, Variegated Copper Ore, Erubescite, Sulphide of Copper and Iron in varying proportions.*

Specific Gravity, 4.5-5.4. Hardness, 3. Occurs usually in compact granular masses. Copper-red to brown in color, showing iridescence where tarnished. Lustre metallic. Found in most of the copper deposits of Virginia particularly those of the Virgilina district, and at various points on the copper belt running from

Virgilina through Halifax, Charlotte and Prince Edward Counties.
See also Copper Ore.

BOULANGERITE: *Sulphide of Antimony and Lead.*

Specific Gravity, 5.5-6. Hardness, 2.5-3. Found in plumose masses of crystalline structure; also granular and compact. Metallic lustre. Color, bluish lead-gray. Occurs as fine fibrous crystals associated with lead and zinc in Walton and Tinder Mines, Louisa County.

BUILDING STONES: An abundance of stone of many kinds, suitable for building purposes, is found over a large part of the State. Some of the deposits, notably the granite quarries of Henrico and Chesterfield Counties have been extensively worked, and the stone is well known in many parts of the country, but in the main the development of the building stone deposits, has only been sufficient to supply local demand.

The list of stones found, includes light-gray, dark-gray and red granite, gneiss, diabase or trap, red, brown, and white sandstone, slate, steatite or soapstone, serpentine, limestone and marble of various colors, including some fine statuary marbles.

From the coast to the eastern edge of the primary rocks, which may be represented by a line running south from Alexandria through Fredericksburg, Richmond, Petersburg and Emporia, the surface rocks are of the Tertiary Age and furnish no building stone of consequence.

The chief source of the building stone is the belt of Archæan or crystalline rocks extending across the State from the line above mentioned to the eastern edge of the Blue Ridge, and running in a southwesterly direction parallel to that range. It furnishes gneiss granite, slate, trap, steatite, serpentine, limestone and marble.

Within the above area are several narrow isolated belts belonging to the Triassic formation, yielding red and brown sandstone, while overlying the primary rocks at its extreme eastern edge, there is a belt of sandstone, running more or less continuously, from Petersburg to the Potomac.

West of the Blue Ridge, the chief building stones occurring, are the sandstones, limestones and marbles of the Valley of Virginia.

GRANITE, GNEISS AND TRAP: The most important granite quarries are those of Henrico and Chesterfield Counties in the immediate vicinity of Richmond. The gray biotite granite from these quarries is well known and has been used extensively in all the Atlantic cities.

The principal public buildings which have been built of it are the postoffice and city hall, Richmond, and the postoffices at Philadelphia and Harrisburg, Pa.

The chief individual quarries are those of the Richmond Granite Company, and Old Dominion Granite Company, on the north side of the James, and those of Netherwood, Mittendorf, Wray, Brown and McCoy, south of the river. All of these quarries are producing massive gray biotite granite for monumental work, paving stones and general building purposes.

Near Tuckahoe, Henrico County, a quarry was opened, but is not at present operative, which furnished the stone for the Washington monument in Richmond. The stone is fine grained in one part of the quarry, and coarse in another, and is noted for its great durability.

Several varieties of granite are quarried near Petersburg on the Appomattox. These are gray and occasionally greenish-gray in color, both fine and coarse grained in texture, and are noted for their strength and decay-resisting properties.

West of Richmond the granite becomes gneissoid in character, and many fine exposures occur all along the James River Valley. A few of the quarries that are being worked, or have been worked, may be mentioned, but there are numerous localities along the James River, between Richmond and Lynchburg, where good quarries could be opened, with very good shipping facilities.

At Columbia in the southeast corner of Fluvanna County, a gray biotite gneiss is obtained from the quarry of J. F. Seaz.

In Willis' Mountain, Buckingham County, a unique gneiss of

a rich pink or purple color occurs in great abundance, and from its hardness and great durability, constitutes a valuable building material.

Near Buckingham Courthouse, an exposure of a beautiful coarse grained granite occurs, favorably situated for working. Still further west in Amherst and Campbell Counties near Lynchburg, a bluish-gray biotite gneiss is quarried for general building purposes, and is used in Lynchburg, Danville and other points. In the Amherst County quarries on the north bank of the James, opposite Lynchburg, the rock can be readily split out in slabs from three inches to any desired thickness. In the same district an exceptional gneiss quite free from iron is quarried on Fishing Creek about a mile and a quarter from Lynchburg.

Between Lynchburg and the Blue Ridge, many exposures of syenitic gneiss and trap occur. Near Harris' Creek, a few miles above Greenway, a dark syenitic trap was much used in the construction of the locks and culverts of the canal. The rock is hard but easily dressed, and very resistant to decay.

In Bedford County, a dark variegated gneiss is quarried at the Eagle Eyre quarry, and a black trap which is very close-grained and hard, and takes a high polish, is found at Coleman's Falls.

A valuable lighter colored trap occurs at Collins' Ferry which has been quarried for millstones; the same variety is also found on Buffalo Creek and Whipping Creek, Halifax and Campbell Counties.

A good deposit of red granite well suited for ornamental and general building purposes, which is as yet undeveloped, occurs at Saxe, Charlotte County, on the land of the Jeremy Improvement Company.

In the northern part of the State, a quarry has been opened at Catlett Station, supplying the trap for paving blocks and sewer construction in Washington.

SANDSTONE: Many beds of sandstone of various colors, and in some places, of great thickness, occur in different localities.

On the belt of rocks of this character already referred to as overlying the extreme edge of the primary rocks from Petersburg to the Potomac, many quarries have been opened and extensively worked at different times.

In the neighborhood of Fredericksburg and Acquia Creek, the quarries show thick beds very uniform in texture, and varying in color from nearly white to brownish gray. The gray sandstone used in the construction of the White House and old portion of the Capitol was quarried at Acquia Creek by the United States Government.

Of the sandstone quarries found in the isolated belts of the Triassic formation, that at Manassas, in Prince William County, is most important. It is very similar to the well known Seneca sandstone at the mouth of Seneca Creek, Maryland. The Manassas quarry has been extensively worked, and the stone has been used in the construction of public buildings in Washington, Baltimore, Danville and Charleston, West Virginia.

A bed of a beautiful pinkish-brown sandstone is found near Warminster, Buckingham County, and similar beds occur in the same formation in Orange County.

At Naruna in Campbell County, on the property of Mr. John W. Scott, a compact pink-brown sandstone of excellent quality occurs, which has been used locally to some extent for sills, chimneys, etc.

A very fine bluish-gray sandstone was extensively quarried near Lynchburg. At Leesville in Bedford County, and at various points between Scottsville and Lynchburg, on a continuation of the same belt, valuable beds of quartzite or quartz slate are found.

The deposit at Lee's Mountain near Leesville, consists of very large layers of this mineral with a pronounced slaty structure, so that it is easily quarried out in slabs of any desired size and thickness from one inch upwards. It is capable of being highly polished, and is very suitable for interior decoration, table tops, etc. A special branch of furniture manufacture for which it would be particularly suitable, on account of its not being affected by carbonic or other acids, is fittings for the soda fountain

business. Its acid-resisting property would also make it a valuable material for acid tower construction in chemical works.

Frequent extensive exposures of white or yellowish-gray sandstone occur along the western side and base of the Blue Ridge; particularly in Page, Rockingham, Augusta and Rockbridge Counties, but they have not received any attention for building purposes.

In Southwest Virginia sandstones occur at various points. At Big Stone Gap, in Wise County, gray, pink and brown varieties suitable for building purposes are found. Similar beds occur in Bland County, near the Courthouse, and at Pulaski City, in Pulaski County.

The marble and limestone deposits, though extensive, have not been developed to any extent for building purposes. An important deposit is found at Craigsville, Augusta County. It produced a unique and beautiful crenoid marble, fine grained and semi-crystalline, of a pinkish-gray color, and capable of a high polish. It was extensively used in New York, Baltimore, Boston, as well as St. Louis, Chicago and other western cities, for interior work in buildings, furniture, and ornamental purposes.

A very fine white marble having all the characteristics of statuary marble is found near the mouth of the Tye River, in Nelson County.

Throughout the Valley of Virginia many bands of limestone occur of a color and texture which entitle them to be considered as ornamental marbles. The following varieties are mentioned by Prof. W. B. Rogers:

Dun-colored marble of homogeneous and close texture, susceptible of fine polish. This marble is abundant in the northern and middle Counties of the Valley. Among the localities where it is found may be mentioned, near New Market and Woodstock, in Shenandoah County, and on the east side of Massanutton Mountain in Page County.

Mottled bluish marble, also capable of good polish, though not so fine grained as the preceding variety, is also found near New Market, and is traceable for miles.

A massive fine gray marble is exposed on Stone Run about three fourths of a mile southeast of Buchanan, underlying dark blue limestone. White marble is found at several points in the Valley, but a particularly fine variety, very close grained and capable of taking very high polish, occurs in Rockbridge County about five miles from Lexington, the exposure being about 15 feet thick.

Red marble occurs as a compact massive deposit near Chapman's Ferry, Giles County, and a red and grayish mottled variety is found in abundance in Scott County, a short distance west of the courthouse.

At Rockbridge Baths, Rockbridge County, on the lands of G. M. and T. F. Anderson, there is a deposit of beautiful onyx marble, very compact in texture and susceptible of high polish.

A fine grained black variety occurs near Blacksburg, Montgomery County, and at several other points in Southwest Virginia good deposits may be found which are as yet entirely undeveloped.

SLATE: Next to the granite, the fine roofing slate beds of Buckingham County have been more developed than any other building material in the State, and are of great importance on account of the quality and extent of the deposits. The principal belt is on Hunt's Creek in the neighborhood of New Canton, and quarries have been opened along this creek for several miles. The slate beds have a general northeast strike, and the dip of the strata is almost vertical. The slate splits easily and with good regularity into sheets of any desired thickness. It has a fine texture, is very dense, and resists atmospheric influences admirably.

The two chief quarries presently operative, are those of Messrs. J. R. Williams & Company, of Richmond, and Mr. A. L. Pitts, in the same vicinity, both of which are being successfully worked on a large scale.

The same belt has been opened at several other points both north and south of the river, to a small extent, with every indication of the same excellent quality of material being found at depth.

Further west near the base of the Blue Ridge, in Amherst and Bedford Counties, another belt of slate occurs which is believed to be of the same geological age as the Buckingham belt. Large exposures are found north and south of the river a few miles below Balcony Falls, and several quarries have been opened, yielding slate of fine quality. On the northern side about two miles northeast of the river, the Virginia Slate Mining Company are working a large quarry, producing a dense fine grained roofing slate of excellent quality.

STEATITE OR SOAPSTONE: A belt of this material runs in a southwesterly direction through Albemarle, Nelson and Amherst, with occasional deposits in Campbell and Bedford Counties. The most important portion of the belt is that lying in Albemarle County. At Alberine on the Southern Railroad and near Schyler Postoffice, Nelson County, the deposit is being very extensively worked. The soapstone is tough, compact and very regular. Almost all the product from these quarries is put on the market in the form of manufactured articles such as wash tubs, fireplaces, grates, etc.

Between the two quarries above mentioned--a distance of about eleven miles, the soapstone can be traced almost continuously.

In Southwest Virginia near Troutdale, Meadow Creek, and Coal Creek, Grayson County and in Floyd County near the courthouse, other deposits of steatite occur.

CALAMINE: *Hydrous Zinc Silicate*, $2 \text{ Zn O}, \text{ SiO}_2, \text{ H}_2\text{O}$.

Specific Gravity, 3.4-3.5. Hardness, 4.5-5. Rhombic prisms; also massive, mammillated or stalactitic. Color, whitish, sometimes bluish, greenish or brownish. Vitreous lustre. Transparent to translucent. Streak white.

Found in the Zinc mines of the Bertha Zinc Company, Wythe County.

CALCITE: *Calc Spar, Iceland Spar, Calcium Carbonate*. CaCO_3 .

Specific Gravity, 2.5-2.8. Pure crystals, 2.71. Hardness, 3.

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Various crystalline forms—tabular or prismatic; often granular and compact. Also fibrous, stalactitic or nodular. Fine crystals abound in many of the limestone quarries of Shenandoah Valley.

CASSITERITE: *Tin Stone, Tin Dioxide, SnO₂.*

Specific Gravity, 6.8-7.1. Hardness, 6.7. Composition, Tin 78.67 per cent. Oxygen 21.33 per cent. Crystals prismatic, very frequently in twins; also found massive, in grains, reniform and fibrous. Color, brown, black, yellow or white, the crystals having an adamantine lustre. Streak, brown, yellowish brown, yellow or white.

In 1883 a well defined lead of tin ore was discovered on Irish Creek in the eastern corner of Rockbridge County. Much interest was aroused in the find, and a considerable number of openings were made on the vein, but the work was done very injudiciously, and through lack of capital to thoroughly prosecute the development, the operation did not achieve any satisfactory results. The tin area extends from a few miles north of the James River, along the east edge of Rockbridge County parallel to the Blue Ridge, into Nelson County. The veins occur in the crystalline rocks of the Blue Ridge, underlying the Potsdam sandstone. The rocks are chiefly coarse hornblende and porphyritic granite, and at some points, mica schist. The general strike of the veins, which are almost vertical, is nearly north and south. The veins are undoubtedly true fissures, containing at times almost pure tin ore, and at other points with quartz replacing or partly replacing the ore. At the surface the veins are small, the pure tin ore varying from seven inches to less than one inch in thickness. The development work has not been sufficient to permit of any estimate of the extent or value of these deposits being made, but the amount of high grade cassiterite obtained from the surface work, and the well defined character of the veins, undoubtedly justify more careful and systematic explorations.

CERRUSITE: *Lead Carbonate, White Lead Ore, Pb CO₃.*

Specific Gravity, 6.46-6.5. Hardness, 3-3.5. When pure, contains Oxide of Lead 63.5 per cent. Carbonic Acid, 16.5

per cent. Crystals, prismatic, pyramidal, or tabular, occurring often in twins, and six rayed groups. Often massive, granular and compact, but rarely fibrous. Color, white, gray, grayish-black, sometimes tinged blue or green by some of the salts of Copper. Transparent to sub-translucent.

Found occasionally in the Bertha Zinc Mines, Wythe County, Virginia.

CHABAZITE: *Hydrous Calcium-Aluminum Silicate*, $C_3Al_6(SiO_4)_3(Si_3O_8)_{3-18}H_2O$.

Specific Gravity, 2. Hardness, 4.5. Always found as nearly cubical crystals. Color, white or colorless, gray, yellowish, brick-red and flesh-red.

Has been found in Mica mine at Amelia Courthouse.

CHALCANTHITE: *Blue Vitrol, Copper Sulphate*. $CuSO_4 \frac{1}{2} 5H_2O$.

Specific Gravity, 2.1-2.3. Hardness, 2.5. Crystals, oblique prisms; also as efflorescence or incrustation, massive, stalactitic or fibrous. Color, deep sky-blue. Streak, uncolored. Vitreous lustre. Occurs in most of the sulphide copper ores of Virginia, notably in ores in Charlotte and Buckingham Counties. *See Copper Ores.*

CHALCEDONY: *A Crypto-crystalline variety of Quartz*, SiO_2 .

Specific Gravity, 2.62. Hardness, 7. Color, usually pale-gray, bluish, whitish, or light brown. Translucent, with waxy lustre. Formed in cavities by the deposition of silica from silicious waters.

Found in Bland, Montgomery and Giles Counties.

CHALCOCITE: *Copper Glance, Redruthite, Copper Sulphide*, Cu_2S .

Specific Gravity, 5.7. Hardness, 2.5-3. Composition, Copper 79.8 per cent. Sulphur 20.2 per cent. Occurs as prismatic crystals; also massive, granular, or compact. Color, dark lead or steel gray to black, with metallic lustre; sometimes tarnished blue or green. Occurs associated with Bornite and Chalcopyrite in

many of the Virginia copper ores, particularly in the Blue Ridge copper district in Orange County. *See Copper Ores.*

CHALCOPYRITE: *Copper Pyrites, Copper Iron Sulphide, Yellow Copper Ore, Cu Fe S₂.*

Specific Gravity, 4.1-4.3. Hardness, 3.5-4. Lustre, metallic. Color, brass yellow, subject to tarnish and often iridescent. Streak, greenish black. Opaque. Fracture conchoidal, uneven. Composition, Copper, 34.8 per cent. Iron 30.5 per cent. Sulphur 34.9 per cent. Distinguished from iron pyrites, by its deeper yellow color, and being much softer. Chalcopyrite is found in all the copper mines of Virginia, with the exception of those of the Virginia belt, and constitutes the principal ore of copper mined in this State. It is also found in the pyrites mines of Louisa County. *See also Copper Ores.*

CHERT: *Hornstone—a variety of Chalcedony.*

Chert is a term often applied to any impure flinty rock, including the Jaspers.

It occurs in all the limestone deposits in Virginia, sometimes in bands several feet thick. In Montgomery and Giles Counties, beds of Chert occur which verge into burr stone of an open vesicular structure.

In the first named County, heavy deposits of flint occur as boulders in clay, cresting the hills along Tom's Creek Valley.

CHLORITIC GROUP: This is an important group of silicates of a green color closely related to the micas, but differing from the latter in containing little or no calcium or alkalis.

Chloritic minerals form a considerable portion of the crystalline rocks of the Piedmont region of Virginia, and examples of the various members of this group are found all over the above area.

CHLORITE: *Ripidolite, Hydrous Magnesium-ferrous-aluminum-Silicate. Mg₃Fe Al₂Si₂O₁₁ $\frac{1}{4}$ 4 H₂O.*

Specific Gravity, 2.65-2.85. Hardness, 1.5. Usually occurs in dark olive green masses, having a granular texture; also foliated like talc and in radiated form. Rarely in hexagonal crystals.

Lustre, a little pearly. Subtranslucent to opaque. Laminæ inelastic. Chlorite and chloritic slates are abundant in Virginia constituting the country rock over a considerable portion of the crystalline area.

Some samples of chloritic mineral containing platinum are claimed to have been found in Fauquier County, and a sample of chloritic schist carrying Arseno-pyrite, received by us from near Danville, did contain traces of that metal.

CHLOROPAL: *Hydrous-ferric-Silicate.* $\text{Fe}_2\text{O}_3, 3\text{SiO}_2, 5\text{H}_2\text{O}$,
Specific Gravity, 1.80. Hardness, 2.5-4.5. Massive and opal-like in appearance. Of a greenish yellow color.

CHRISTOPHITE: *Black Sphalerite Zinc Blende.* ZnS .

Specific Gravity, 4. Hardness, 3.5-4. A brilliant-black Sulphide of Zinc. Crystals have been found in the zinc deposits of Wythe County and also associated with galena, in cherty limestone in the same region.

CHROMITE: *Chrome Iron Ore.* $\text{FeO Cr}_2\text{O}_3$.

Specific Gravity, 4.3-4.6. Hardness, 5.5. Color, iron-black. Metallic lustre. Occurs in small granules in the eruptive peridotite and pyroxenite rocks, and in the serpentine and talcose rocks derived from the above by alteration.

In Virginia, chromite has only been found in small amount, particularly in Loudoun County; no occurrence of economic importance has yet been discovered.

CHRYSOCOLLA: *Hydrous Copper Silicate.* $\text{Cu Si O}_3, 2\text{H}_2\text{O}$.
See also Copper Ore.

Specific Gravity, 2-2.3. Hardness, 2-4. Occurs usually as incrustations; massive or earthy. Also in thin seams and stains. No fibrous structure apparent nor any appearance of crystallization. Vitreous lustre. Color, bright green, bluish green. Translucent to opaque. Found in the copper mines around Virginia, in Charlotte County and in the Blue Ridge mines.

CLAYS: *Brick Clay, Fire Clay, Kaolin or China Clay, Pottery Clay.*

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Deposits of clay of various kinds from that used for the manufacture of common brick, to pure kaolin or china clay, suitable for use in porcelain making, are found widely distributed throughout the State. The development of the industry, however, has been mainly confined to small brick yards supplying local demands for common building brick; the finer qualities of clay having received very little attention.

The most important clay area of the State is that of the coastal plain, the western border of which may be represented by a line running through Alexandria, Fredricksburg, Richmond, Petersburg and Emporia. This area includes the Potomac, Pamunkey, Chesapeake, Lafayette and Columbia formations.

The first named formation is exposed in narrow belts near the western border of the coastal plain, particularly in the neighborhood of Fredricksburg, and contains many clays valuable for the higher grades of stoneware, tiles, refractory and front bricks.

An extensive deposit of a fine grained gritty clay, with a grayish tint, occurs near Summit Station on the R. F. & P. Railway which is well suited for the manufacture of pressed brick, fire brick, or stoneware. A sample recently examined by us had the following composition:

The sample dried at 212 degrees Far. contains:

Silica.....	63.76 per cent
Alumina.....	24.36 " "
Ferric Oxide	2.00 " "
Lime	trace
Magnesia ..	.38 " "
Potash .....	.50 " "
Soda .....	.32 " "
Loss on ignition	8.64 " "
	99.96 " "

By rational analysis the mineral ingredients in the above were found to be.

Clay substance (Kaolinite).....	59.70 per cent.
Feldspar.....	5.52 " "
Quartz.....	34.78 " "

The dry clay required 27 per cent. water to produce a workable paste, which shrunk 3.5 per cent. on drying and an additional 5.6 on burning, making a total shrinkage of 9.1 per cent. On

firing, incipient fusion took place at 2250 degrees Far. and vitrification at 2500 degrees Far. the brick produced having a very pale buff color.

Many other deposits of a somewhat similar character occur about and below Fredericksburg, which are suitable for pottery, encaustic tiling and terra cotta ware.

In the Pamunkey and Lafayette formations there are considerable beds of brick clay at places, but nothing of much importance.

The Chesapeake formation contains many thick beds of clay, which are exposed at various points along the Rappahannock, Mattaponi, Pamunkey and James Rivers. According to Prof. Rogers the Miocene clays frequently contain sulphate of iron, but many of them are well suited for pottery and brick manufacture.

A sample from this formation from an extensive bed on James River, near Ferguson's Wharf had the following composition:

Silica.....	63.82 per cent.
Alumina.....	17.45 " "
Ferric Oxide.....	4.81 " "
Lime.....	3.08 " "
Magnesia.....	.81 " "
Potash.....	1.97 " "
Soda.....	1.88 " "
Loss on Ignition.....	6.21 " "
	99.83 " "

This clay burns to a dense red brick at a low temperature.

The Columbia formation is the most important source of the loams and other alluvial clays suitable for brick making. It overlies all Norfolk and Princess Anne Counties, and many thick beds of the brick clays belonging to it are found on the terraces of the Rappahannock, Potomac, Mattaponi, York, Chickahominy, Pamunkey and James Rivers.

The loams of this formation are particularly well adapted for brick making, and further north have furnished the most of the bricks used in Washington and Baltimore. They are characterized by a moderate plasticity, and contain sufficient iron to yield a good red color when burned.

West of the coastal plain and extending to the Blue Ridge,

lies the area of crystalline rocks, and residual clays more or less impure, resulting from the decomposition of these rocks are widely distributed.

Beds of kaolin of good quality have been reported from a number of localities, but the development has been slight, and comparatively little is yet known about them.

On the eastern fringe of the area at Bon Air, nine miles from Richmond, a good deposit of kaolin is well exposed in the cut of the Southern Railway. The rational analysis of the crude kaolin dried at 212 degrees Far. yielded the following results:

Clay Substance (kaolinite)	68.55 per cent.
Quartz.....	31.45 " "
Feldspar.....	trace
	<hr/>
	100.00 " "

After washing the dry kaolin had the following composition:

Silica.....	48.71 per cent.
Alumina.....	37.62 " "
Ferric Oxide.....	1.10 " "
Lime.....	.25 " "
Magnesia.....	.14 " "
Potash and Soda.....	traces
Loss on Ignition.....	14.10 " "
	<hr/>
	99.92 " "

This deposit was worked to some extent a number of years ago, and a considerable amount of very pure washed kaolin was shipped.

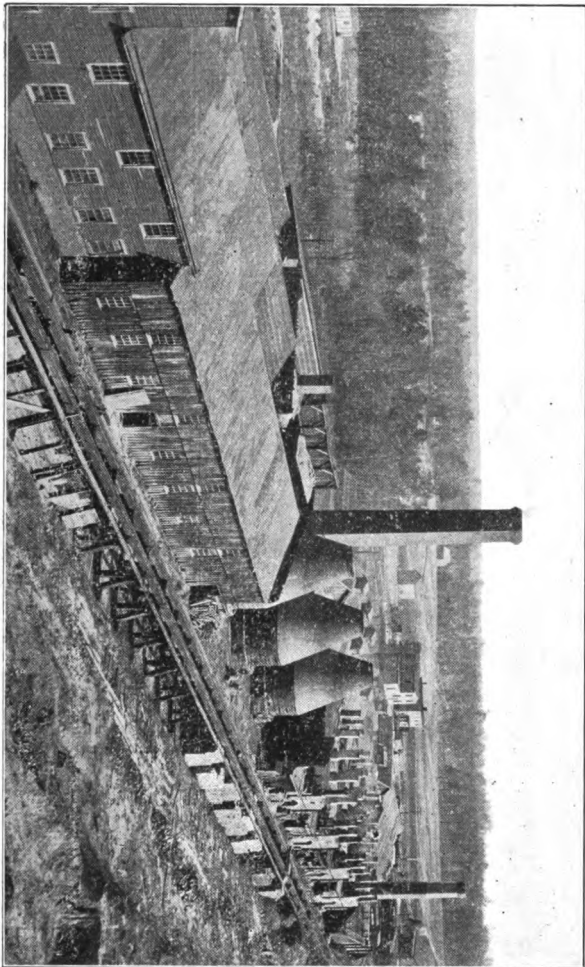
Residual clays more or less refractory are produced by the decomposition of the gneiss and granite, and occur as thick beds at various points along the eastern edge of the crystalline area.

At Clayville, Powhatan County, extensive works are in operation manufacturing light-colored pressed brick, which have a large sale in Richmond and other cities.

At Lorraine, in Henrico County, on the land of Mr. F. B. Deitrick, extensive deposits of a very fine grained plastic clay occur, which is well suited for the manufacture of stoneware.

The clay is very dense and tough and remarkably free from grit: A workable paste, which is very plastic, is obtained with 35 per cent. of water. This paste shrinks 12 per cent. on air-drying

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THE POWHATAN MANUFACTURING COMPANY, AMELIA COUNTY.

and an additional 7 per cent on firing, and burns to a dense hard brick, bright red in color, at 1750 degrees Far. Its composition is as follows:

(SAMPLE DRIED AT 212 DEGREES FAR.)

Silica	62.80 per cent.
Alumina	21.30 " "
Oxide of Iron	4.80 " "
Lime .....	.54 " "
Magnesia .....	.57 " "
Potash	2.35 " "
Soda .....	.83 " "
Loss on Ignition	7.00 " "
	100.19 " "

A rational analysis showed it to have the following mineral composition.

Clay Substance (kaolinite).....	60.90 per cent.
Feldspar.....	16.71 " "
Quartz.....	22.39 " "
	100.00 " "

A deposit of crude kaolin has recently been developed to some extent near Abbeyville, Mecklenburg County, on the property of the Kaolin Mining and Manufacturing Company

The mass, which is apparently a very large one, is in three layers separated by thin bands of ochre, and samples from each of the layers drawn and analyzed by us had the following composition:

(SAMPLES DRIED AT 212 DEGREES FAR.)

	No. 1 layer, 4' thick,	No. 2 layer, 2' thick,	No. 3 layer, 30' thick.
Silica	69.40 per cent.	69.01 per cent.	60.36 per cent.
Alumina	20.85 " "	20.97 " "	24.82 " "
Ferric oxide	1.40 " "	1.36 " "	1.60 " "
Lime .....	.14 " "	.11 " "	.40 " "
Magnesia	trace	trace	.43 " "
Potash	2.03 " "	2.01 " "	2.60 " "
Soda .....	.79 " "	1.19 " "	4.72 " "
Titanic Acid.....	.65 " "	.65 " "	1.01 " "
Loss on Ignition	4.70 " "	4.62 " "	3.93 " "
	99.96 " "	99.92 " "	99.87 " "

The clay slacks to a very lean mass possessing slight plasticity. Briquettes shrunk 2.5 per cent. in air-drying and additional 2.5 per cent. on firing, and at a temperature of 2250 degrees Far. burned to a hard, cream colored brick.

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Deposits of kaolin and fire-clay are reported at various points along the James River Valley, in Powhatan, Cumberland and Appomattox Counties. In Campbell County near Lynchburg, on the land of Messrs. Carroll Brothers a deposit of excellent kaolin occurs. It is pure white in color, and very pure as shown by the following analysis of it made by us:

(SAMPLE DRIED AT 212 DEGREES FAR.)

Silica	45.13 per cent.
Alumina.....	37.96 " "
Ferric Oxide.....	.24 " "
Sulphuric Acid.....	.01 " "
Phosphoric Acid.....	.01 " "
Lime (Ca O).....	.85 " "
Magnesia (MgO).....	.23 " "
Soda.....	.52 " "
Potash (K ₂ O).....	.31 " "
Water and Loss.....	14.59 " "
	99.59 " "

At the same place a yellow clay which makes a bright-red, strong brick and a blue plastic clay suitable for pottery ware are found.

Their composition is shown in the following analyses:

(SAMPLE ORIED AT 212 DEGREES FAR.)

	YELLOW CLAY.	BLUE CLAY.
Silica	61.75 per cent.	44.70 per cent.
Alumina.....	21.46 " "	35.59 " "
Ferric Oxide	6.76 " "	3.46 " "
Manganese Oxide.....	" "	" "
Sulphuric Acid .....	.02 " "	.08 " "
Phosphoric Acid .....	.06 " "	" "
Lime (CaO) .....	.65 " "	1.76 " "
Magnesia (MgO) .....	.33 " "	.12 " "
Soda (NaO) .....	.87 " "	.16 " "
Potash (K ₂ O) .....	.73 " "	.87 " "
Water and Loss.....	7.22 " "	13.55 " "
	99.85 " "	99.79 " "

In Rockbridge County, near the mouth of North River, fire-clay said to be of a superior quality has been mined. Large beds also occur in Amherst and Bedford Counties.

West of the Blue Ridge deposits of kaolin are reported at Black Rock, Lipscomb and Sherando, Augusta County; also near Wytheville, Wythe County, and in Henry and Patrick Counties.

The deposit at Sherando, about seven miles southwest of Waynesboro, has been worked to a slight extent at various times, producing pottery, fire-brick and tiles.

It covers considerable area and has a thickness in places of 30 feet. A section shows on the surface sand, gravel and cobbles, next, a bed of yellowish silicious clay, and underlying it, the white kaolin deposit. The latter is a fine grained plastic material, very free from quartz. A sample analyzed by us had the following composition:

Silica	47.90 per cent.
Alumina	39.86 " "
Ferric Oxide.....	.24 " "
Lime .....	.23 " "
Magnesia .....	.19 " "
Alkalis	1.55 " "
Loss on Ignition.....	9.85 " "
	99.72 " "

Fire-bricks made of a mixture of this clay and the more silicious clay overlying it have given good results in practice.

Many deposits of impure residual clays from the decomposition of the Cambro-Silurian rocks, are found throughout the Valley of Virginia, and are used to supply the local demand for common building brick.

Highly refractory clays occur at many points in the coal measures of Southwest Virginia, but so far have received little or no attention.

COAL: The coal-bearing formations cover an area of about 2120 square miles, of which 1850 square miles belong to the Northern Appalachian coal field, situated in the southwest border Counties of the State, and the remainder to the Triassic coal field, the chief deposits of which are those of the Richmond coal basin.

It is estimated that 50 per cent. of the area of the Triassic field and 80 per cent. of the area of the Appalachian field, contains beds of workable coal.

The most important deposits in the Appalachian region are those of the Pocahontas Flat Top Field, in Tazewell County, The Clinch Valley, and Big Stone Gap districts in Wise and Lee

Counties, and the hard coals of Price and Brush Mountains, Montgomery County.

THE FLAT TOP FIELD: This coal field is a triangular-shaped region, with an area of about 150 square miles, consisting of the Great Flat Top Mountain and its spurs running southeast to the Bluestone River. It lies partly in Tazewell County, Virginia, but mainly in Mercer, Wyoming, McDowell and Raleigh Counties, West Virginia.

The formation, which has a thickness of 1000 to 1100 feet, belongs to the lowest member of the Coal Measure (the great conglomerate of other sections and has been named by Prof. Fontain the "Quinnimont Group.")

The stratification is regular, and almost horizontal, the slight dip to the northwest being about 25 to 30 feet to the mile. Thirteen beds of coal are exposed, varying in thickness from 1 foot to 12 feet, the total thickness of the coal beds of the series being about 47 feet.

COAL BED NO. 3: Also called the "*Nelson or Pocahontas Bed*," is the most important and extensively worked of the series. The numerous operations on it, on the outcrops on the sides of the ridges lying between the many small streams emptying into the Bluestone, show that it varies from 4 to 12 feet in thickness. At Pocahontas its thickness is 11 feet to 8 inches, the structure from the roof to the floor according to Prof. A. S. McCreath, being as follows:

Coal, bony	0' 8"
Coal with irregular thin slate streaks.....	4' 8"
Slate.....	0' 0½"
Coal	6' 0"
Slate.....	0' 3"
Coal	1' 0"
Total thickness of bed	12" 7"
Thickness of coal to be mined	11" 8"

The average thickness of the two overlying workable beds, No. 5 and No. 6 is about 3 feet 6 inches.

From many analyses and exhaustive practical trials, the

unequalled character of the coal from this field for steam raising and coking purposes, has been fully demonstrated. The following table of analyses taken from Prof. McCreath's report, shows its average composition compared with that of other standard coals:

NAME OF COAL.	MOISTURE. Per cent.	VOLATILE MATTER Per cent.	FIXED CARBON. Per cent.	SULPHUR. Per cent.	ASH. Per cent*
Flat Top Coals, average of 10 samples.....	.694	18.832	74.066	.761	5.647
Flat Top Coals, average of 8 samples, No. 3. Bed...	.698	18.756	73.406	.753	6.388
Cumberland Coal, average of 2 samples. ....	.985	19.139	72.708	.787	6.408
Clearfield Coal, ave age of 3 samples	1.186	22.168	69.270	.983	6.443
Broad Top Coal ... ..	.594	17.551	71.334	.976	9.545
Connellsville Coking Coal	1.260	30.107	59.616	.784	8.233
Westmoreland Coal	1.430	36.145	55.891	.989	5.5 5
Cardiff Coal, Wales.....	2.552	33.123	56.774	1.323	6.225

The Clinch Valley and Big Stone Gap Fields in Wise County embrace an area of about 300 square miles, all of which is underlaid with coal, and most of it contains two or more beds of workable thickness

In the Clinch Valley district the Coal Measures belong to the Middle Coal Series of Virginia, which are identical with the Lower Productive Coal Measures of Pennsylvania. A general section of the Measures is given by McCreath and D'Invilliers as follows:

1. Edward's Coal Seam on hill top 4' 4" to 5' 6"
Interval: Slate and thin sandstone about 400'
2. Upper Banner Coal Seam; averaging 5' to 6½"
Interval: Shales 100' to 125'
3. Lower Banner Coal Seam; averaging 3' to 4' 2"
Interval: Shale and massive sandstone..... 65' to 75'
4. Widow Kennedy Coal Seam; averaging 5' to 6'
Interval: Shale and thin sandstone ... 165' to 200"
5. Imboden Coal Seam; averaging 3' 4" to 4' 6"
Interval: Largely sandstone 100' to 150'
6. Jawbone Coal Seam; averaging 6' to 11'

The coal from the various beds is of excellent quality; very regular in composition, and suitable for steam, coking and domestic uses. The following table of analyses from the report of

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McCraith and D'Inwilliers gives the average composition of the different beds:

	JAWBONE SEAM AVERAGE OF 4 ANALYSES.	KENNEDY SEAM AVERAGE OF 3 ANALYSES.	LOWER BANNER AVERAGE OF 3 ANALYSES.	UPPER BANNER AVERAGE OF 3 ANALYSES.	EDWARDS 1 SAMPLE.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Water.....	1.072	.909	.883	.625	.870
Volatile matter	33.239	34.331	34.195	34.028	33.365
Fixed Carbon..	51.488	59.888	60.091	59.394	56.07
Sulphur.....	.714	.797	.866	.600	1.623
Ash	13.487	4.075	3.975	5.358	8.135
	100.000	100.000	100.000	100.000	100.000

The centres of the numerous operations in this field are Tacoma, Coeburn, Tom's Creek, Virginia City and St. Paul.

On Tom's Creek the Mines of the Virginia Iron Coal and Coke Company have a capacity of 1,200,000 tons annually, and 800 bee-hive coke ovens are in operation with an annual output of 350,000 tons of coke.

The following are analyses of the coal mined at Tom's Creek and the coke produced from it:

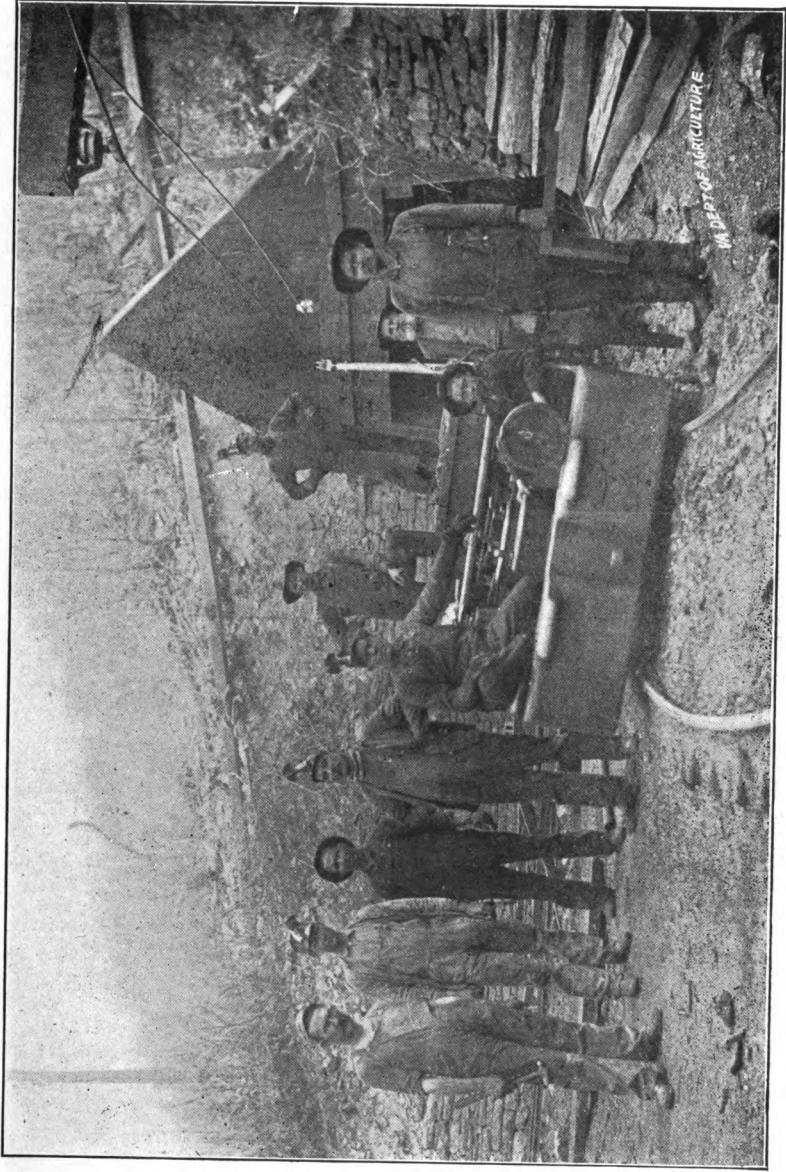
	COAL.	COKE.
Fixed carbon.....	63.400 per cent.	88.01 per cent.
Volatile matter	31.290 " "	1.86 " "
Ash	3.445 " "	10.13 " "
Moisture	1.865 " "	" " "
	100.000 " "	100.00 " "
Sulphur	0.576 " "	0.56 " "
Calorific power	15129 B. T. U.	

THE BIG STONE GAP FIELD: This field in Virginia has an area of about 120 miles, lying between Stone Mountain—its southern boundary, and the State line running along the summit of Black Mountain.

Its length from the eastern limit at Norton in Wise County, to Pennington Gap in Lee County, is about 20 miles. The coal measures exposed in this field have a thickness of about 3000 feet, and include the conglomerate series of the Flat Top Field and the Lower Productive Measures of the Clinch Valley District.

More than 20 coal beds are exposed, of which a number are of great economical importance.

Near the crest of Little Black Mountain, a seam of very fine



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splint coal, varying from 5 feet to 7 feet in thickness is exposed, and has been proven very reliable in extent and composition.

Another bed of importance, which varies in thickness from 4½ feet to 6½ feet has been opened and worked to some extent, along the face of Little Black Mountain, about 200 feet from the base. It yields a bituminous coal, which produces good coke.

Of greatest importance, however, in average thickness of the bed, and character of the coal is the "Imboden" seam, said to be identical with the well known "Elkhorn" coking coal of Pike and Letcher Counties, Kentucky.

It varies in thickness from 5 feet to 20 feet, the greatest thickness being in the neighborhood of Stone Mountain, and covers an area in the field of at least 90 square miles. If an average thickness of 5 feet be reckoned over the above area, 400,000,000 tons of coal are estimated to be available from this one bed.

Underlying the "Imboden" bed, another seam of coal, very similar to it in character occurs. It is under drainage over most of the field, and where exposed is much broken up, except at and near Norton at the eastern limit of the field. At this point it is from 8 feet to 10 feet thick with one to three small partings, and is now being extensively worked.

The following table of analysis of the coal from the four seams above described, taken from an article on this field by Mr. James M. Hodge, (Trans. of American Inst. of Min. Eng. 1893), shows the excellent character of the product:

	HIGH SPLINT.	THIRD COKING.	IMBODEN.		
	Average of 2 Analyses.	Average of 2 Analyses.	Pigton Creek.	Looney Creek.	Looney Creek.
Authority.....	P.	P.	McC.	McC.	McC.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Moisture	1.80	1.40	1.464	1.400	1.154
Volatile Matter..	33.90	34.10	36.206	33.660	35.346
Fixed Carbon....	59.25	59.84	59.741	58.365	60.107
Ash	5.05	4.68	1.730	5.70	2.750
	100.	100.			
Sulphur	0.714	0.566	0.799	0.705	0.643
			100.	100.	100.

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Authority.....	LOWER COKING.			
	Mud Lick Ca- lahan Creek.	Black Creek.	Copper Ent. Powell River.	Baker Ent. Powell River.
	McC.	McC.	P.	P.
Moisture	2.008 per cent.	1.161 per cent.	1.000 per cent.	0.80 per cent.
Volatile Matter..	31.437 " "	34.075 " "	33.30 " "	32.01 " "
Fixed Carbon. . .	57.704 " "	54.798 " "	63.0 " "	63.50 " "
Ash.....	8.200 " "	8.250 " "	3.60 " "	3.10 " "
Sulphur.....	0.651 " "	1.717 " "	100.00 " "	100.00 " "
	100.00 " "	100.00 " "		

The Stonega Coke and Coal Company is operating five coal mines in this field, three of which are at Stonega, one at Osaka and one at Roda, in Wise County. It has also 966 bee-hive coke ovens, 666 being at Stonega and 300 at Osaka. Other large operations are those of Virginia Iron, Coal and Coke Company, Imboden Coke Company, Intermont Coal and Iron Company, Norton Coal Company, etc.

The Hard Coal Deposits of Price and Brush Mountain, Montgomery County:

These deposits occur in the Pocono (Vespertine) sandstone formation, No. 10 of the Virginia Series, and in view of the recent extensive and successful development of them by the Virginia Anthracite Coal Company, now have a commercial importance hitherto denied them.

They have been known and worked in a crude fashion for many years, but only supplying local demands, consequently the many openings on the outcrops on Price and Brush Mountains, were never carried further than could be conveniently worked without machinery. Most of the coal obtained from these surface workings contained too high a percentage of ash to enable it to compete with the purer coals of other fields; the deposits, therefore, never got beyond this surface development.

Recent and more systematic work has demonstrated that the coal at greater depth shows great improvement; the formation becomes regular and the percentage of ash is greatly reduced.

The deposits are being vigorously developed by the Virginia Anthracite Coal Company. A standard gauge railroad $6\frac{1}{2}$ miles

long, has been completed from Christiansburg to the mines on Price Mountain, and a breaker with a capacity of 1000 tons per day has been erected.

Two veins occur on all the property. One known as the "Big Vein," averages 5 feet to 8 feet thick, with thin slate partings; the "Little" or "Bottom Vein" varies from 24 feet to 40 feet in thickness, and is practically free from slate.

In the larger vein, which dips at an angle of about 28 degrees, a large working slope has now been driven to a depth of 700 feet, and at this point a section shows 70 inches of coal. The mine is fully equipped with the most modern machinery and is under expert management.

From the results of the completed development, there seems every indication that this property will produce at least 40,000,000 tons of high-grade anthracite, excellently suited for domestic use, the composition of which is shown in the following table of analyses:

	ANALYSIS OF BEST VIRGINIA ANTHRACITE, BY A. S. MCCREATH.		ANALYSIS OF AVERAGE VIRGINIA ANTHRACITE BY FROEHLING & ROBERTSON.
Moisture.....	.620 per cent.	.....	.82 per cent.
Volatile Matter.....	10.520 " "	.....	11.074 " "
Fixed Carbon.....	82.029 " "	.....	80.173 " "
Sulphur.....	.528 " "	.....	.413 " "
Ash.....	6.305 " "	.....	7.520 " "
	100.000 " "		100.000 " "

RICHMOND COAL BASIN: This area is the most important of the Triassic coal fields of the Atlantic Coast, and has been known and worked since the beginning of the 18th century.

Its form is that of a broad basin nearly 10 miles wide in the southern middle portion, tapering towards each end. The northern extremity is in Goochland County, about 9½ miles north of the James River, and it extends for about 31 miles south, embracing part of Goochland, Henrico, Powhatan and Chesterfield Counties. Several outlying basins occur outside the edge of the main area both north and south of the James River.

Although this coal field has been known and worked for an

extended period, being in fact one of the first opened by the miner, the development has been confined to the fringe of the main basin and to the smaller outlying basins on the eastern border. Not more than twelve hundred acres in all have been worked and the central area of the basin has not even been explored.

The eastern edge of the basin is clearly defined, and the coal horizon has been traced except where it is hidden by the alluvial deposits of the Swift Creek drainage area. On the western side, the border is not so clearly shown, the coal outcrops being mainly found in the region of the James River.

The part of the basin in the vicinity of the James River has been most carefully studied. In this section the beds on the eastern margin dip gently westward with flexures downthrown in the central part; on the western edge the beds are broken and irregular but dip chiefly eastward.

There is also at various parts of the western margin evidence of faulting and in the southern portion, considerable deformation of the strata whereby north and south troughs separated by arches or rolls have been produced. The coal seam frequently pinches out at the crests of these mine arches, but is again found by continuing on the same slope downward and through the roll.

The evidence derived from the mining on the eastern margin of the basin, as well as the results obtained from borings in the tract south of the James, indicate that the dip of the strata in this section carried the coal beds to a depth of twenty-five hundred feet at a distance of about a mile from the eastern edge of the basin.

The development along the eastern outcrop of the main basin, has been mainly at three points—at Gayton (Carbon Hill) north of the James, where the mines of the Richmond Coal Mining and Manufacturing Company are located; at the Midlothian Mines about five miles south of the River, and at Winterpock (Clover Hill) in the southern part of the basin

In the Gayton field four workable beds are found. Nearest

the surface there is a bed of natural coke 5 to 6 feet thick underlying which are three beds of bituminous coal. The one nearest the coke is a good workable bed 5 to 7 feet thick; the next is four feet, and the bottom bed, which is banded with slate, is 5 to 10 feet thick.

At these mines two shafts have been sunk to the natural coke seam, about half a mile apart, and slopes have been driven along the seam for about 1500 feet, the two slopes being connected by a gangway. The bituminous seams have been worked by a separate shaft and slope, the latter being 1660 feet long, and reaching a perpendicular depth of about 600 feet.

The mines have not been working for a few years, but have recently been unwatered preparatory to a resumption of operations.

In the old Midlothian mine one of the beds has an average thickness of 20 feet. The shaft reached this seam at 722.5 feet, and 36 feet of coal was found at this point. A sinking shaft was put down in 1874 to a depth of 1022 feet and bored an additional 317 feet in an attempt to reach the deeper beds of the Midlothian field, but was abandoned before the coal horizon was reached. Three beds are reported by Heinrich in the Grove shaft south of Midlothian, the upper of which was $14\frac{1}{2}$ feet, the middle 12 feet and the lower $3\frac{1}{2}$ to 4 feet thick.

This field has not been worked since the surface equipment was burned a few years ago. It is stated that the old workings showed plenty of good coal in sight, and the mines are now being unwatered for reopening.

At the Winterpock (Clover Hill) mine the Raccoon slope exhibits three seams. The top and bottom seams are 4 feet thick while the middle one varies from 18 to 30 feet.

The coal produced from the Richmond field, is of two kinds --a normal bituminous and coking coal, and natural coke or carbonite. The bituminous coal is very black and bright in appearance, fairly hard and strong, and yields an excellent strong coke. The following analyses shows the composition of the coal:

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COLLIERY	ANALYST	MOISTURE PER CENT	VOLATILE MATTER PER CENT	FIXED CARBON PER CENT	ASH PER CENT	SULPHUR PER CENT	FUEL RATIO
Midlothian (average)	W. R. Johnson	2.455	29.796	53.012	14.737	.068	2.20
Midlothian (screened)	"	1.785	34.497	54.063	9.655	.203	1.84
Clover Hill	"	1.339	31.698	56.831	10.132	.514	2.11
Barr's Deep Run	"	1.785	19.783	67.958	10.475		3.43
Gayton (Carbon Hill)	O. J. Heinrich	1.40	20.60	60.80	17.20		
Crouch & Sneads (Gayton)	W. R. Johnson	1.785	23.959	59.976	14.280	.427	2.50
Midlotnian	Froehling & Robertson	1.931	33.426	53.314	11.329	.204	1.93
Gayton	"	.640	33.470	62.320	3.570		1.97

The natural coke or carbonite is found usually in one of the seams at least, in the basin of the James River. It is the result of the intrusion of igneous matter, either as a dike cutting upward across the bed, or as a sill following the upward rise of the seam. The coke is of two kinds, depending on its proximity to the igneous rock. That found close to the dike, or sill is very hard and cellular, burns slowly except under strong draft, snaps when burning, and is known as hard or popping coke. The better quality, which is suitable for household use, is found further removed from the dike or sill, as dense blue-black masses, and is known as soft or free-burning coke.

The following analyses give the composition of some samples:

COLLIERY NATURAL COKE	ANALYST	MOISTURE PER CENT	VOLATILE MATTER PER CENT	FIXED CARBON PER CENT	ASH PER CENT	SULPHUR PER CENT	FUEL RATIO
Gayton	O. J. Heinrich	1.57	9.64	79.93	8.86		3.29
Gayton	Dr. Wallace Glasgow	1.56	14.26	81.61	.224	.33	5.72
Midlothian	Froehling & Robertson	1.63	13.47	75.94	8.96	1.70	5.63
Gayton	"	1.03	8.28	80.55	10.14	1.86	9.73
Gayton	"	1.49	12.68	77.14	8.74	2.01	6.11

As regards prospective development, it may be stated that these deposits possess many of the conditions necessary for the growth of a highly successful coal field.

They are within a few miles of Richmond and Tidewater, having therefore an assured local market, and cheap transportation to other large centers of the eastern seaboard. The coal is of

excellent quality, and the main seams developed are of great thickness. On the other hand, the geological structure of the field is such as to present many new difficulties and problems to the miner, as the conditions existing in this field are peculiar and difficult.

The coal producing vegetation originally grew very close to the granite bottom of the basin, in some parts of the field only a few inches of slate have been found separating the coal from the rock, and consequently the coal deposits originally followed the rough, irregular formation of a granite basin. In addition to this, after the coal formation and the deposition of the overlying sandstone strata, the beds were subjected to more or less displacement by extensive disturbances in the crystalline bed-rock, consequently the geological structure of the basin is one of great intricacy.

The prevailing practice in the operations in the past has been to develop from the coal outcrops on the margin of the basin or from shafts sunk near the outcrops, without any exploration by drilling of the ground in advance of the workings, consequently nothing is known of the coal beds underlying the central part of the basin.

There is, however, no reason to doubt that the coal deposits underlying this area are very extensive, but the problem of their winning must be undertaken with the fullest possible knowledge of the existing conditions, and careful and modern methods of mining.

FARMVILLE AREA: In this basin, which has an area of about 60 square miles, lying in Buckingham, Cumberland and Prince Edward Counties, a number of thin seams of bituminous coal have been found, but no development has taken place, except to a very slight extent on the thin seams outcropping around the margin, and nothing is known of the interior of the basin.

The most promising portion of the area is a small detached basin six miles south of Farmville.

TAYLORSVILLE AREA: Coal is reported to have been found on this area, which lies on the extreme edge of the Piedmont

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district about 20 miles north of Richmond. Exposures are found near Taylorsville on the R. F. & P. Railroad, but so far the results of investigation have not offered any inducement to lead to development.

COLUMBITE: *Iron-manganese-niobium-tantalate*, $(\text{Fe Mn})(\text{Nb Ta})_2\text{O}_6$.

Specific Gravity, 5.3-7.3. Hardness, 6-6.8. Color, pitch black, brownish-black or grayish, often showing characteristic iridescence. Lustre, sub-metallic or vitreous. Streak, dark or reddish-brown. Crystallizes in rectangular prisms usually in parallel groups. Very fine crystals of Columbite are found in the feldspar of the Mica mine at Amelia Courthouse, Amelia County.

COPPER, NATIVE: Cu.

Specific Gravity, 8-8.9. Hardness, 2.5-3. Occurs in hackly masses, in sheets, and in arborescent and filiform shapes. Color, copper-red. Ductile and malleable.

Native copper occurs finely disseminated through the igneous rocks of the Blue Ridge Copper belt, together with Cuprite and Malachite. *See Copper Ores.*

COPPER ORES: The occurrence of copper ores in Virginia, particularly in the Appalachian region, was known in very early times. Old pits and surface workings showing copper ore, which are said to antedate the Revolutionary War, are found in various localities in Southwest Virginia, but no actual mining is known to have been carried on until after the discovery of the Ducktown, Tennessee copper deposits in 1850. Following that discovery, a great deal of exploration was done on the extensive gossan covered deposits in Grayson, Carroll, and Floyd Counties; the search being mainly directed to the finding of black copper ore similar to that occurring at Ducktown. Considerable quantities of this ore were mined and shipped, but when the rich ores were exhausted, and the underlying pyrrhotite carrying but a small percentage of copper was reached, the workings were gradually abandoned.

The Virginia copper deposits occur in four principal localities: In Southwest Virginia, in Grayson, Carroll and Floyd Counties

in the Virgilina belt and the continuation of this belt running in a northerly direction through Halifax, Charlotte and Prince Edward Counties; in the auriferous quartz veins in Buckingham, Louisa, Fluvanna and Goochland Counties, and in the igneous rocks of the Blue Ridge, notably in Warren County.

The deposits in these four localities are each representative of one of the four types of copper deposits occurring in the Southern States, as described in Mr. Walter H. Weeds' valuable article "Types of Copper Deposits in the Southern United States." (Trans. Am. Ins. of Min. Eng. 1900.)

The Grayson, Carroll and Floyd deposits are the immense pyrrhotite copper bearing veins underlying the "great gossan lead." These pyrrhotite veins are similar to the well known Ducktown, Tenn. deposits, and are a continuation of the Ore Knob deposits in Ashe County, North Carolina. From Ore Knob the lead may be traced north to the Virginia line, then, being deflected toward the northeast, it runs through Grayson, Carroll and Floyd Counties. In the western part of Grayson County the lead is only visible here and there, but after passing New River the "gossan" cap is found in immense masses, and continues practically without break for a distance of five miles.

The vein reaches the great width of 200 feet in places, but the average width is from 20 to 40 feet. It is a true fissure vein, the filling being chiefly pyrrhotite. Some pyrite is found in places, and the copper occurs as chalcopyrite disseminated through the mass.

In formation, extent and character of the ores, the great pyrrhotite bodies of Southwest Virginia, particularly in Carroll County, resemble the deposits of the Ducktown district. The same rich copper ores were found in both, underlying the gossan cap, and when these ores were exhausted mining operations ceased in both fields. The Ducktown Mines, however, were reopened, and working on a low grade pyrrhotite ore, are now able to produce 15,000,000 pounds of copper per annum. The copper in the Ducktown ores is said to run about 3 per cent., while in the Virginia field it varies from 1 to 5 per cent. with occasional rich

shoots of almost pure chalcopyrite. The development in the latter field has not been sufficient to definitely determine the average amount of copper that may be expected in the various ore bodies, but there is every reason to believe that very large masses exist, containing quite as much copper as the Ducktown ores, and which would yield as favorable results if developed on a large scale with the same skill and liberal capital expenditure.

The Virgilina Copper belt, situated in Halifax County, Virginia, and Granville and Person Counties, North Carolina, has attracted much attention of recent years. Development work has progressed steadily, and several of the mines are in a position to make regular shipments of ore as soon as railroad connection is obtained.

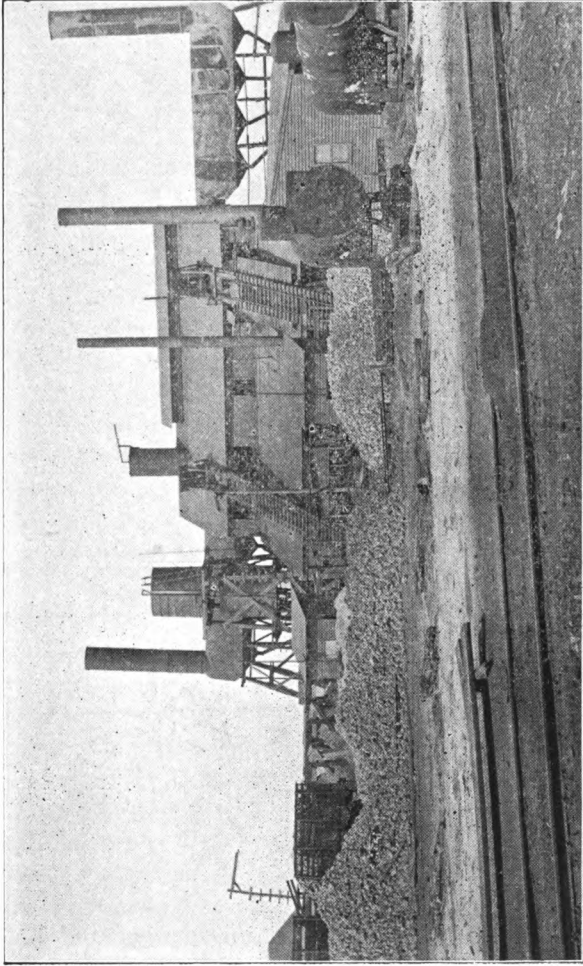
The "Holloway" Mine, which has railroad facilities, has already shipped over 20,000 tons of ore averaging about 8 per cent-copper to the Eustis Smelter at Norfolk.

The country rocks in this belt are schists, with a strike nearly north and south, and the veins are true fissures, in the main conforming with the schists, but in some instances crossing them, and are made up of a succession of lenses connected by quartz stringers.

The ores are chalcocite, bornite, cuprite and malachite.

The best developed mine is the "Holloway," situated about four miles south of the town of Virgilina. It is owned by Mr. W. E. C. Eustis, of Boston, who has developed it carefully along sound lines. It is now 500 feet deep, and is being worked by levels north and south of the shaft every 50 feet from 75 feet down. The vein varies in width from 3 feet to 75 feet, the copper occurring as chalcocite.

On the same vein as the "Holloway mine," are the "Yancey" and "Durgy," situated eight miles south of Virgilina. These properties show excellent prospects of ore in good quantity, which averages about 10 per cent. copper, and only await railroad connection to begin regular shipments. The mines have been developed to a depth of about 150 and 90 feet respectively.



EUSTIS COPPER SMELTER, NORFOLK, VIRGINIA.

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Numerous other mines have been opened and partially developed both north and south of the Virginia-Carolina line, among which should be mentioned the "Blue Wing," three miles south and the "Anaconda" one and a half miles north of Virgilina, both of which are developed to a considerable extent, and have produced and shipped good ore.

One of the most promising of the various mines in Halifax County is the "High Hill," situated nine miles north of Virgilina. The quartz outcrop of the vein varies from 3 to 15 feet in width and is easily traceable for about a mile south from the bank of the Hycó River. The mine has been opened by shafts and pits at numerous points along the outcrop, in all of which ore is found. Eight shafts varying from 50 to 170 feet in depth have been sunk, with levels at various depths, and considerable ore has been stoped out. The ore is bornite, malachite and tetrahedrite, and averages about 15 per cent. copper with small gold and silver values.

On the continuation of the Virgilina belt running through Halifax, Charlotte and Prince Edward Counties, openings have been made at many points, and development is progressing with good prospects.

In the southwest portion of Charlotte County, near Red Oak, the Carnegie Copper Company have recently opened up a vein on their property, and have already secured some good ore, consisting of bornite, malachite and glance.

In the same County about one and one half miles from Keysville, a number of veins of the Virgilina type are found, and have been investigated to some extent during the past year.

On one of the properties, the quartz vein can be readily traced for 1800 feet, running nearly north and south, and a number of holes opened on it have all shown copper. A shaft has been put down to a depth of 43 feet, and when examined by us at 30 feet, the vein had a width of 81 inches, and contained 39 inches of copper ore in three bands, separated by slate. An average sample of the ore at this depth yielded 10.25 per cent. copper. The results of the prospecting at this point, have been such as to justify the development of several of the veins found in this vicinity.

In Buckingham County several copper deposits occur belonging to the type of the auriferous quartz vein, which have been more or less developed during the past few years. Among these may be mentioned the "Lightfoot" and the "Staples" Mines.

At the former, some very fine chalcopyrite has been obtained at a depth of 120 feet, carrying nearly 40 per cent. copper. Near Dillwyn the Q. Q. Copper Company have recently begun to develop a very promising deposit on their property. The shaft has been carried to a depth of about 60 feet, at which point the vein carries 4 feet of very fine ore—chalcopyrite and melacconite, yielding on the average 12 per cent. copper. Arrangements are now being made to vigorously prosecute this very promising deposit.

About 13 inches of pure chalcopyrite occurs next the footwall of the well known pyrite veins of Louisa County.

The copper deposits of the Blue Ridge belong to what is called the Catoctin type, from their frequent occurrence in the Catoctin schists. These ores consist of native copper with copper oxides and carbonates occurring along the cleavage surfaces in the epidotic and chloritic schists, as well as in the metamorphic massive igneous rocks.

These ores seem to be produced by the leeching of the copper from the igneous rocks, with concentration and subsequent deposition within the fractures of the vein.

As a rule the copper values do not continue at any great depth.

Considerable work has been done at various times on these ores, the most promising region being on and near High Knob, a spur of the Blue Ridge, near Linden, Warren County.

The rock at this point is a hard bluish green altered basalt, in which native copper, cuprite, malachite, and occasionally some azurite occur along the cleavage lines, or in thin quartz veins.

In Green County, five miles north of Stanardsville, some development work has been done in ore of a type similar to that occurring at Linden, and a considerable amount of good ore has been obtained.

CORUNDUM: *Oxide of Aluminum.* Al_2O_3 .

Usually occurs in six sided prisms; also granular massive. Colors, blue, grayish-blue, gray, red, brown or black. Hardness, 9.—next to the diamond. The importance of this mineral as an abrasive, gives great interest to its occurrence in various parts of the Appalachian crystalline belt. This crystalline belt is continuous from central Alabama to New Jersey. It is made up principally of gneisses, with masses of granite and dikes of basic igneous rocks. A narrow belt of basic magnesian rocks traverses about the middle of the crystalline area, forming as a rule small lenticular masses. The chief deposits have so far been found in these peridotite rocks. This belt is well defined through Virginia, numerous outcrops being known, and while very few occurrences of Corundum have been reported in this State, there would seem to be good reason to believe that it will be found in several localities. Crystals have been obtained from Louisa and Patrick Counties.

CUPRITE: *Red Copper Ore,* Cu_2O .

Specific Gravity, 5.9-6.1. Hardness, 3.5-4. Crystallizes in regular and modified octahedrons; also massive, granular and sometimes earthy. Color, red or dark-red. Streak, cochineal-red, brick-red or crimson-red. Brittle. Composition, Copper, 88.8 per cent., Oxygen, 11.2 per cent. Occurs associated with native copper in the mines of the Blue Ridge from Stanardsville to the Potomac River. *See Copper Ores.*

CYANITE: *Kyanite,* Al_2SiO_5 .

Specific Gravity, 3.6. Hardness, 5-7. Usually occurs in long thin-bladed reticulated crystals; sometimes columnar and finely fibrous. Color, pale bluish-green to sky blue, with vitreous to pearly lustre.

Found in gneiss and mica schist in Buckingham and Spottsylvania Counties; also in the Rutherford Mica Mine, Amelia County.

DOLOMITE: *Pearl Spar, Calcium Magnesium Carbonate,* $(\text{Ca Mg } 2 \text{ CO}_3)$.

Specific Gravity, 2.8-2.9. Hardness, 3.5-4. Crystallization, rhomboidal, with faces of the rhombohedrons often curved.

Usual structure, granular massive, occurring in extensive beds. Color, generally white, but often tinged yellow, red, green, brown or black, due to metallic oxides. Lustre, vitreous to pearly. Nearly transparent to translucent. Dolomite is very widely distributed throughout Virginia, constituting much of the "Great Magnesian" limestone formation of the Valley of Virginia and Middle James River belt. *See Limestone.*

EMERY: Emery is a mixture of Corundum in very fine granular condition, magnetite, and sometimes hematite. It feels and looks like fine grained iron ore for which it is frequently mistaken. One of the few occurrences of emery in Virginia, is as a heavy ledge near Whittle's on the line of the Southern Railroad in Pittsylvania County. This deposit, of which analysis is given below, is very hard and tough, but somewhat deficient in abrasive power:

Alumina	55.74	per cent.
Ferric Oxide	15.50	" "
Ferrous Oxide.....	20.77	" "
Silica.....	.68	" "
Titanic Oxide	1.86	" "
Soda.....	3.95	" "
	<hr/>	
	99.50	" "

EPIDOTE: *Pistacite. Hydrrous Aluminum-ferric calcium Silicate.*

Specific Gravity, 3.25-3.5. Hardness, 6.7. Prismatic crystals, sometimes fibrous. Occurs massive granular and forming rock masses. Color, yellowish-green (pistachio green) gray, brown, or almost black; also occasionally yellow and red. Transparent to opaque with vitreous lustre. Epidote is a very frequent constituent of the crystalline rocks of Virginia, especially in the hornblende schists. A sample from near Shadwell Station, Albemarle County, on the Chesapeake & Ohio Railroad analyzed by us had the following composition:

Silica.....	37.80	per cent.
Alumina.....	18.27	" "
Ferric Oxide	13.25	" "
Ferrous Oxide.....	5.80	" "
Lime (CaO)	21.15	" "
Magnesia (MgO).....	1.42	" "
Water	1.75	" "
	<hr/>	
	99.34	" "

FELDSPAR: *See Orthoclase. Albite. Labradorite.*

FERRO-CALCITE: *Calcium-iron-Carbonate.*

Found in the gray veins of the so-called Onyx Marbles of Page, Rockingham and Scott Counties.

FIRE-CLAY: *See Clays.*

FLINT: A variety of Quartz. *See Chert.*

FLUORITE: *Fluorspar. Calcium Fluoride. Ca F.*

Specific Gravity, 3-3.25. Hardness, 4. Cubical crystals most common. Occurs also granular compact, and massive. Colors, white, green, purple or clear yellow; these are the most common, but red or sky blue specimens are sometimes found. Transparent or translucent, with vitreous lustre. Occurs in gneiss and in pegmatic dikes in various parts of Virginia. Finely crystallized cubes and octahedrons are found near Woodstock, Shenandoah County, and the massive variety, mostly of a light green color, in the mica mines of Amelia County.

GALENA: *Galenite. Lead Glance. Lead Sulphide. Pb S.*

Composition when pure, Lead 86.6 per cent., Sulphur 13.4 per cent. Specific Gravity, 7.25-7.35. Hardness, 2.5. Color and streak, lead-gray. Shining metallic lustre. Crystallizes in cubes and octahedrons.

Galena occurs in many localities in this State, particularly in Wythe, Pulaski, Smyth, Giles, Bland, Tazewell, Russell, Scott and Grayson Counties. In Wythe County, the lead and zinc ores exist in very large bodies over an extensive area. In the Wythe County lead mines at Austinville on New River, the galena, with occasionally some carbonate of lead, occurs along with zinc blende, smithsonite and calamine in large more or less lenticular masses in the magnesian limestone. The deposits have been worked for over a century and thoroughly proven over a length of more than two miles, by shafts and tunnels. The principal vein is 40 feet thick, and is reached by a tunnel 1600 feet long. The workings have been carried to a depth of about two hundred feet without

reaching the bottom of the deposit. After concentration the lead ore contains from 55 per cent. to 75 per cent. of metallic lead, and 3 per cent. to 7 per cent. zinc, while the concentrated zinc ore yields about 30 per cent. zinc and 10 per cent. lead.

Galena is also found at other points in Wythe County, particularly in the Bertha Zinc Mine, in the eastern end of the County and in the Forney Mine a little to the west of the Bertha; also at Sayers on Little Reed Island Creek, and on Upper Cripple Creek. Pulaski County also embraces a portion of the lead and zinc basin, and galena, zinc blende and other lead and zinc minerals are mined on New River about two miles below the mouth of Reed Island Creek. At Tract Mountain and in the lower Helderberg limestone of Big Walkers Mountain in the same County, galena also occurs but has not yet been developed to any extent.

In Smyth County near Sugar Grove, in the South Fork Valley, galena is found in what is apparently the same strata, that carry the extensive lead-zinc deposits of Wythe County and the indications at this point are such as to justify more development work than has yet been done.

Other points of lesser importance at which galena occurs are: In the lower Helderberg rocks on Dismal Creek and East River in Giles County; near Sharon, and in Garden and Flat Top Mountains in Bland County; on Clinch River near the mouth of Maiden Spring fork, Russell County; on Little River in Floyd County; Peach Bottom copper lode, Carroll and Grayson Counties; in the Faber Mine, Albemarle County and in the Allah-Cooper, Taft and Walton Mines in Louisa County.

GARNET: *Andradite. Lime-iron-Garnet.* $3\text{CaO} \cdot \text{Fe}_2\text{O}_3 \cdot 3\text{SiO}_2$.

Specific Gravity, 3.6-3.9. Hardness, 6.5-7.5. Colors, various shades of red, (ruby-red, Hyacinth-red and brownish-red) to wine yellow, green and black. Crystals occur of various sizes from a pin's head to several inches in diameter, in dodecahedrons and trapezohedrons, sometimes variously modified. It is found in many of the gneisses; in micaceous and hornblendic schists; sometimes in serpentine, and also in trap and other igneous rocks.

Beautiful specimens have been secured from the wall rock of the Mica Mine near Hewlett's Station, Hanover County; also in the neighborhood of New Canton and Gravel Hill in Buckingham County.

GLAUCONITE: *Green Earth. Hydrous Iron-potassium Silicate.*

Specific Gravity, 2.2-2.4. Hardness, 2. Occurs as dark-olive-green to yellowish-green grains, with dull lustre. Contains from 5 per cent. to 12 per cent. of Potash.

It is this mineral that is the characteristic constituent of the "green sand marls" or Eocene marls, so abundant in the tidewater regions of Virginia, and which makes these marls of so much value as fertilizers. Large deposits of marl carrying varying quantities of Glauconite are found along the banks of the James, Pamunkey, York, Rappahannock and Potomac Rivers and tributaries.

A deposit from 10 to 20 feet thick is exposed along the James River almost continuously from Coggin's Point to a little above City Point, a distance along the River of about eleven miles.

The great value of these green sand marls of Tidewater Virginia was fully pointed out by Prof. Rogers, but they have received comparatively no attention.

GNEISS: A rock having the same constituents as granite but with the ingredients arranged more or less in layers, and so usually capable of being quarried out in slabs. This is the most commonly occurring rock in the Southeastern and Southern portions of Virginia. *See also Building Stones.*

GOETHITE: *Hydrous Ferric Oxide, Fe₂O₃. H₂O.*

Specific Gravity, 4-4.4. Hardness, 5-5.5. Color, yellowish to dark brown, with sub-metallic lustre. Occurs in prismatic crystals; also acicular, stalactitic, radiated and fibrous. Frequently found in cavities in the limonites and hematites of Southwest Virginia.

GOLD: Au.

Specific Gravity, 15.6-19.3. Hardness, 2.5-3. Occurs native in strings of crystals forming arborescent shapes; also in nuggets,

grains, thin plates and in masses. The color varies from very pale yellow when alloyed with much silver, to the golden yellow of pure gold.

It is very malleable and ductile, and these properties alone readily distinguish it from iron or copper pyrites—minerals which are frequently mistaken for gold.

The gold mines of Virginia are found within the area of crystalline rocks which extends unbroken from Montgomery County, Maryland, in a general northeast and southwest trend through Virginia, North Carolina, South Carolina, Tennessee, Georgia, to near Montgomery, Alabama.

The western boundary of this belt in Virginia, runs parallel to and on the east side of the Blue Ridge, while its eastern edge may be represented by a line running almost due south from Washington, skirting Richmond, to the North Carolina line.

Within this region occurs the auriferous belt following the same general northeast and southwest trend, and varying in width from 9 to 20 miles, with a total area of more than 4,000 square miles, the best developed portion being in Fauquier, Culpeper, Stafford, Orange, Spottsylvania, Fluvanna, Louisa, Goochland and Buckingham Counties. West of the Blue Ridge there is another small belt of minor importance in Montgomery, Floyd and Grayson Counties.

The country rocks of the crystalline area are micaceous, garnetiferous and chloritic gneisses and schists, with frequent occurrence of granite and diabase dikes. The prevailing dip of the rocks is to the east, at steep angles.

The auriferous vein matter is variegated quartz, frequently containing pyrites, sulphurets of copper, and occasionally some galena.

The veins occur as irregular lenses of varying size, and in general conform to the strike and dip of the country rock.

The wall rock of the quartz veins invariably shows much modification in structure and composition, and is frequently auriferous from the penetration of small stringers of vein matter

—facts which point to the formation of the veins being of a later period, than that of the country rock.

The existence of gold in this belt, particularly in Spottsylvania and adjacent Counties was known in early colonial days, but the first actual mint returns from Virginia date from 1829. From that year until the beginning of the war, the mint deposits were about one and a half million dollars. After the close of the war there was considerable activity in these gold fields, and milling and reduction plants were erected at various points. These attempts at development, however, met with little success, and most of the ventures have been practically abandoned.

In many instances the failures must undoubtedly be attributed to inexperienced mining and bad management—conditions under which none of the gold mines of the Southern Appalachian region can be profitably operated.

It is true that the surface ore of most of the veins was rich—in some instances exceptionally so, owing to the local concentration of the gold from the erosion of the upper part of the vein, and practically all the gold produced in Virginia, has been obtained from these decomposed outcrops, and from placer deposits, but the main bodies of the ores, though often present in large amount, are low grade. Below water level, the ore in most of the mines, carries sulphurets, in which only a portion of the gold is in the free state, and the problem in the successful operation of most of the mines in this belt, is the recovery of the gold from these low grade sulphurets carrying from \$4 to \$7 per ton. Since the gold they carry is only partially free, amalgamation does not yield satisfactory returns, and must be supplemented by treatment of the mill tailings. Until the introduction of the Thies chlorination process, no successful method for the treatment of these low grade sulphurets had been found, but from the highly satisfactory results which have attended the working of this process, under careful and scientific management, in other parts of the Southern Appalachian field, there is no reason why its application to some of the ores in this belt, should not be attended with profitable returns.

This process is in operation at the Haile Mine, Lancaster County, South Carolina, and Franklin Mine, Cherokee County, Georgia, and in view of its applicability to many of the sulphuretted ore bodies in this belt, a brief description of the process, as worked at the Haile Mine, is here given, the description being obtained from the valuable paper of Messrs. Nitze & Wilkins (Trans. Am. Inst. of Min. Eng.—1895).

The ore is a silicious micaceous and argillaceous schist impregnated with auriferous pyrites, some free gold and small quartz stringers. The percentage of sulphurets in it varies from 2 per cent. to 25 per cent., and the ore is milled so as to yield 7 to 8 per cent. of sulphurets. It is first crushed to $1\frac{1}{2}$ inch size in Blake crushers, and conveyed to the mill bins in 3 ton narrow gauge, bottom dumping cars. The mill has 60 stamps, 30 on each side, back to back, and was built by the Mecklenburg Iron Works, of Charlotte, North Carolina. The crushing capacity is two tons per stamp in 24 hours. Each stamp has chilled iron shoes and dies, weighs 750 pounds, and drops 6 inches, 86 times per minute. The amalgamation is effected in the mortar by a curved front plate of No. 7, silver plated sheet copper, having a surface of $1\frac{1}{4}$ square feet, which is attached to the lip of the mortar immediately below the discharge, and can be readily removed. Outside the mortar the amalgamating plates are of No. 12, silvered sheet copper, with an area of 32 square feet to each battery of 5 stamps. These are the full width of the mortar and are arranged in four steps, each 2 feet long, and overlapping the next by one inch, the inclination being two inches per foot. There are three additional plates with an area of 12 square feet arranged so that the pulp drops from one to the other before entering the main launder.

The inside plates are removed and cleaned every 24 hours; the outside plates being cleaned when necessary. About one-third of the gold is caught on the inside plates.

The pulp passes to 20 Embrey concentrators, through rifle-lined launders, 80 feet long. The belts of the concentrators travel 5 feet per minute, receiving in that time 192 percussions. The

product contains 90 per cent. iron pyrites and has an average value of \$25 to \$35 per ton.

The concentrates are then roasted in two double-hearth reverberatory, and one revolving pan-furnace, the sulphur being reduced from 43 per cent. to about $\frac{1}{4}$ per cent. Each double-hearth furnace has a capacity of 2 tons of roasted concentrates per 24 hours, a similar output being obtained from the revolving pan furnace in the same time.

The cooled ore is elevated to the top of the chlorination house which contains three chlorination barrels, eleven filtering tanks, two storage tanks, and three precipitating vats.

The chlorination barrels are of cast iron, and are each 60 inches long and 42 inches in diameter.

Each barrel is charged with about a ton of roasted concentrates, 120 gallons of water, from 8 to 11 pounds of bleaching powder and 12 to 15 pounds of sulphuric acid. It is then closed and revolved for three hours at the rate of 15 to 18 revolutions per minute, after which time it is opened and the contents discharged through a lead-lined semicircular trough, on to 4 lead-lined filters on the floor below.

These filters are 6 feet by 8 feet, by 18 inches deep, and the filtering medium is one to two inches of clear sand on the top of four inches of coarse pebbles $\frac{1}{8}$ inch to $\frac{1}{2}$ inch in size, supported on a wooden rack resting on perforated tiles on the bottom of the filter. After the solution has passed through, the pulp is washed twice with water, which removes all traces of chloride of gold. The filtered solution is stored in two tanks, and goes from these to the precipitating tanks as required. The latter are of wood coated inside with asphalt and are eight feet in diameter, and three feet high. In these the gold is precipitated in the metallic state, by fresh ferrous sulphate solution, and after thorough settling, the gold precipitate is drawn off, filtered on paper and dried. It is then mixed with half its weight of borax and soda, in equal proportion, melted in graphite crucibles, and cast into ingots 990 fine.

The cost of roasting and chlorinating one ton of concentrates is given as \$3.02 equivalent to \$0.19 per ton of ore mined.

The enormous bodies of free milling and sulphuret ores, such as exist in the Haile Mine, cannot be found in Virginia, but many of the larger ore bodies in this belt, which were abandoned after the free milling ores had been worked out, and the sulphurets below water level reached, might be made to yield remunerative returns, by the application, under careful management, of the Thies process or by the Cyanide process, applied to the roasted sulphurets.

At the Morrow Mine, in Buckingham County, an attempt was made in 1893-4 to work the sulphurets by the Mears' chlorination process. The experiment failed on account of the mechanical defects in the process used, though a satisfactory gold extraction was obtained.

The operations at the Hughes' Gold Mine, situated five miles from Brems, in Fluvanna County, may be cited as an instance of the successful application of the Cyanide process to a typical ore of the Virginia belt.

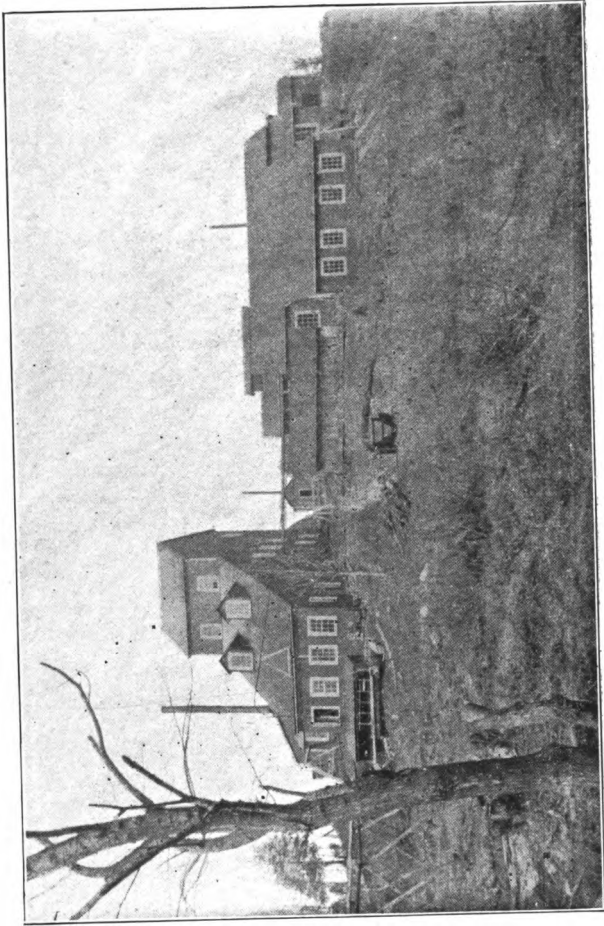
The veins developed at this mine are quartz carrying pyrite, chalcopyrite and galena.

On the main vein, which varies from 1 to 5 feet in thickness, a shaft has been opened to a depth of 60 feet, while on a cross fissure about 2 feet in thickness, another shaft has been carried to a depth of 110 feet.

The ore is conveyed in half-ton dumping cars by an elevated trestle to the top of the mill house, and is there delivered to the stamp battery. The pulp from the stamps passes to four Frue concentrators, from which the high grade sulphurets are conveyed to a double hearth reverberatory roasting furnace, and the tailings pass direct to the cyanide department.

The roasted sulphurets and tailings are subjected to cyanide extraction and the gold recovered from the cyanide solution by means of charcoal—a novel means of precipitation which has been found to yield excellent results.

The charcoal is periodically burned, the ashes smelted with litharge in crucibles, and the bullion obtained for mint shipment



HUGHES GOLD MINE, FLUVANNA COUNTY.

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by cupellation. A maximum extraction of 98½ per cent of the gold content of the roasted sulphurets, is obtained by the above process.

According to Mr. Wm. Bugbee, the manager of the mine, the told extraction of the heavily sulphuretted ore is 90 per cent. of assay value, effected at a total cost for mining, milling, and general expenses, of \$3 50 per ton of crude ore, on an output of 100 tons per week.

Several of the mines on the Fisher lode in Louisa County, present opportunities of development along these lines. This lode has been proven persistent and continuous over a length of several miles, by numerous mines opened on it to a maximum depth of 250 feet; the most prominent of these openings are the Luce, Slate Hill, Warren Hill, Louisa and Harris Mines.

Another type of ore occurring in this belt, of which the Tellurium Mine is the best known example, is that of the heavy sulphuret, carrying small gold values. Over \$1,000,000 is stated to have been taken from the Tellurium Mine, and when operations were discontinued, the ore carried about \$10.00 per ton.

Ore of this character and value if worked on a large scale by roasting, followed by chlorination or cyaniding, should yield a fair margin of profit under careful management.

The mines which have been most extensively worked at various times are located on a number of parallel veins, forming a belt about 15 miles wide, running from Fauquier and Stafford Counties, southwest through Orange, Spottsylvania, Louisa, Goochland, Fluvanna and Buckingham. Gold is also found on the continuation of the same belt in Appomattox, Prince Edward, Charlotte, and Halifax, but no operations have been carried on in the last named Counties.

Around the juncture of the Rappahannock and Rapidan Rivers in Fauquier, Culpeper, Orange, Spottsylvania and Stafford Counties, there is a group of mines, all of which have yielded considerable gold. In the southern part of Fauquier County near Morrisville are the Leopold, Franklin and Wycoff Mines.

The Eagle, Monroe and Lee Mines are situated in the western part of Stafford County. The Eagle was extensively worked until 1894 by the Rappahannock Gold Mining Company. Large amounts of nuggets, some of them of considerable size, were obtained from the Rattle Snake, a gulch-placer mine northwest of the Eagle. In Spottsylvania County, southwest of the Stafford group, some of the oldest mines of the State are located. That of the United States Mining Company in the northwest corner of the County, was extensively worked as early as 1835, yielding at that time an ore of average value of \$25 per ton. The Marshall and Gardiner mines are in the same locality. Continuing southwest, in the same County are the Whitehall, Higgins, Pulliam, Grindstone Hill, Johnstone, Mitchell and Goodwin Mines.

In Orange County are the Vaucluse, Orange Grove, Greenwood and Melville Mines, and further west the De Grasty Mine.

The Vaucluse was one of the earliest mines in which milling was practiced, its plant in 1843 being valued at \$70,000. The Culpeper mine is 18 miles west of Fredricksburg on the Rapidan River and the Richardville and Ellis' are in the same neighborhood.

At least four well defined parallel lodes traverse the central part of Louisa County, in a southwesterly direction, and several important mines have been opened on the various veins. Near Mineral City are the important pyrite mines. These immense lenses of pure pyrite, carry only a trace of gold, though gold bearing quartz veins are found in the hanging and footwalls with occasional chimneys of rich ore.

At the northern extremity of the pyrite mines are the well known Tinder Flats placer deposits, from which a large amount of gold was taken by primitive methods in earlier days. Recent and exhaustive mill tests of the gravel from all over this deposit, have yielded about 40 cents gold per ton, and a company is now putting in a steam dredge and other modern machinery, to work it on a large scale.

Northeast of the Tinder Flats is the Allah Copper Mine, while on the same lode but half a mile southwest of the pyrites

mines, is the Walton, from which some very rich ore has been obtained.

Parallel to the pyrite vein but two miles further east is the Fisher lode already referred to.

The Luce Mine on this lode is situated about a mile from Pendleton Station. It has been developed to a depth of about 250 feet, and drifts over 1,000 feet in length have been opened along the vein, which has a thickness of from 3 to 8 feet. A Frazer & Chalmers 30 stamp mill is on the premises. The Slate Hill Mine adjoins the Luce on the southwest, and has also been extensively worked. A Huntington mill-plant was erected in 1895.

Southwest of the Slate Hill, on the same lode, and on the south side of South Anna River, is the L'aigle D'or Mine, while still further southwest along the boundary of Goochland and Fluvanna Counties, the Busby, Fisher and Moss Mines were extensively worked prior to the war.

The last named mine, located about 2 miles west of Caledonia, Goochland County, is at present under lease to the Telluric Gold Mining Company, and has been considerably developed by them during the past year. The results of these operations have been very promising, and arrangements are now being made to secure the necessary capital for fuller development.

Two veins traverse the property, extending about 1,500 feet on the strike. One of the veins—the Mass is composed of highly laminated quartz lying in lenticular masses between micaceous slate walls, and dipping normally about 45 degrees southeast.

Down to 130 feet on the dip the gold is practically all free-milling, but immediately below this depth the sulphides are reached.

Assays show values running from a few dollars to several hundred dollars a ton, and a recent sampling of entire workings, gave an average value of \$16.00.

The developments by the present lessees consist of two main shafts, known as Nos. 1 and 2. No. 1 shaft has been carried on a pitch of 55 degrees to a depth of 118 feet, and at this depth

levels east and west have been driven a total length of 285 feet in ore milling \$15.00 per ton. In the west level a small shoot was cut through which averaged about \$150.00 per ton Gold and 40 oz. of Silver.

No. 2 shaft has been carried to a depth of 130 feet, and levels driven 60 feet east and west yielded ore milling \$14.40 per ton.

The milling plant consists of one Frazer & Chalmers battery, of three stamps and another of similar size made by the Mecklenburg Iron Works. The milling practice consists of inside amalgamation plates, and one 4 x 6 feet copper plate, outside of each battery.

Regular assays of tailings indicate an average value of \$2.00 per ton.

The Bowles, Bertha and Edith, Tagus, Belzora, Collins, Walters, Manning and Gilmore Mines located also in Fluvanna and Goochland Counties, have all been the scene of considerable development at different times.

In Buckingham County are found the Booker Mine near Whitehall, and the "London and Virginia," seven miles north of the Booker, which were extensively worked for some years. The ore of the Booker Mine milled \$13.00 per ton. Other mines in the same County are the Morrow, Buckingham, Garnett, Mosley and Morton, all of which were actively worked at one time.

West of the Blue Ridge gold has been mined in Floyd and Montgomery Counties, chiefly in placers along Brush and Laurel Creeks. It is also found in Patrick, Carroll and Grayson Counties in small quantities.

GRANITE: Specific Gravity, 2.5-2.8. An igneous rock usually found associated with the oldest metamorphic rocks. Ordinary granite consists of quartz, feldspar and mica, which ingredients can be readily distinguished by the naked eye in coarse specimens, the quartz being the transparent ingredient, the mica the shining plates or scales, and the feldspar the white or pinkish material.

Hornblende and talc are sometimes present in addition to the above ingredients, or replacing the feldspar and mica.

The common granite is usually gray, flesh-colored, or dark-gray according to its composition. Other varieties, named according to their characteristic constituent are, porphyritic, albitic, microcline, hornblendic, black micaceous, chloritic, etc. *See also Building Stones.*

GRANULYTE: A variety of granite containing very little or no mica.

GRAPHITE: *Plumbago. Black Lead, Carbon.*

Specific Gravity, 2.2. Hardness, 1-2. Crystals, hexagonal. Common structure, foliated or scaly; also massive granular and compact. Plates very flexible. Color, dark-steel-gray to iron-black, with a dull metallic lustre. Feels greasy to the touch, and soils paper.

The purer deposits contain from 90 to 96 per cent. of Carbon.

It is widely distributed throughout the crystalline belt of Virginia, occurring frequently in the mica schists of the Piedmont region. A large exposure of graphitic shale is found on the land of Mr. Sommers near Sommerset, Orange County, and at the same point a vein of iron pyrites mixed with much graphite exists. Near Variety Mills, in Nelson County, graphite, similarly associated with iron pyrites is found. Some very pure specimens have been obtained from near Green Spring, in Louisa County, and in Charlotte County on the road from Drake's Branch to Saxas, some good specimens have been obtained. Masses of graphite are said by Rogers to occur in Amherst and Buckingham Counties, and its occurrence near Jefferson Postoffice, Powhatan County, is reported.

The bulk of the graphite found in Virginia is of the amorphous variety, which has to be very pure to be of much value. Some of the graphitic shales, however, contain the more valuable crystalline form, which could be separated from the shale by crushing and wet concentration.

GYPSUM: *Hydrous Calcium Sulphate*, $\text{CaSO}_4, 2\text{H}_2\text{O}$.

Specific Gravity, 2.31-2.38. Hardness, 1.5-2. Flat, prismatic or acicular crystals. Common structure, fibrous, columnar, granular, and compact massive. The crystallized varieties are usually nearly or quite transparent; the massive, translucent to opaque. Color, white, gray, yellow, brown, reddish-brown to black. The principal varieties of the mineral are:

Selenite—Transparent colorless crystals or foliated masses.

Radiated or Plumose Gypsum. Radiated structure.

Fibrous Gypsum or Satin Spar.

Snowy Gypsum.

Alabaster or Compact Massive Gypsum.

Earthy or Rock Gypsum.

Ground raw Gypsum is extensively used in agriculture under the name of "land plaster." Calcined and ground, it constitutes "plaster of paris." The alabaster varieties are used for statues and other ornamental purposes.

Gypsum occurs in small quantities in various parts of the State, but the only locality in which it occurs in large quantity, is the Valley of the Holston, in Smyth and Washington Counties, in Southwest Virginia. These extensive deposits have been known since the early part of the nineteenth century, and the occurrence of the accompanying salt brines, was known at a still earlier period.

The Gypsum deposits occupy deep basins eroded in the Lower Carboniferous shale or limestone, and in the calcareous Knox sandstones. The origin of these remarkable deposits has been variously explained by different authorities. Prof. W. B. Rogers was of the opinion that the Gypsum was the result of the decomposition of pyritic slate, in contact with fragments of limestone; others consider them as derived from the evaporation of sea water, or lakes, with resulting deposition of the Gypsum and salt, or from the action of sulphur springs on the limestone. The results of the latest geological work done on this field, favor the theory of deposition from sea water.

The Gypsum occurs in huge irregular masses imbedded in dark colored or reddish clays, and is usually covered with only a few feet of earth. Underlying it at various depths, are extensive deposits of rock salt. The great thickness of these deposits is indicated by the fact that borings have been made at several points to a depth of 600 feet passing through nothing but gypsum and gypsum bearing slates. Below that depth there is about 200 feet of salt beds and enclosing rocks, the total depth of the basin being estimated as about 1000 feet.

Development of the deposits is being carried on at a number of points along the belt, the total production during 1901 being 15,236 tons.

By far the most extensive operations in the district are those of the Beuna Vista Plaster and Mining Company at Plasterco, about a mile southeast of Saltville. The bed worked at this point is thirty feet thick, and has been mined to a depth of 280 feet. About 11,000 tons per annum are mined, part of which is ground for land plaster, and part calcined for plaster of paris. A certain amount of the calcined material is made into wall plaster by the addition of retarder and hair.

The following analyses of the crude and ground rock from these mines, made in this laboratory, show its average composition:

	RAW ROCK.		GROUND ROCK FOR
	No. 1.	No. 2.	LAND PLASTER.
Lime	33.26 per cent.	35.32 per cent.	31.83 per cent.
Sulphuric Acid.....	44.74 " "	45.06 " "	40.24 " "
Magnesia.....	.05 " "	.76 " "	1.75 " "
Baryta .....	.19 " "	.33 " "	1.10 " "
Alumina and Iron.....	.46 " "	.09 " "	1.95 " "
Silica.....	.49 " "	.39 " "	1.68 " "
Water.....	20.85 " "	20.80 " "	21.30 " "
	<u>99.98</u> " "	<u>100.01</u> " "	<u>99.84</u> " "

At the Buchanan property, three miles west of Chatham Hill Postoffice, the deposits are being worked by an open cut about thirty feet deep, and fifty feet long. The Gypsum is of excellent quality, and many extensive exposures of it occur in the same vicinity, but the lack of railroad communication, has prevented more than a small development

About three miles east of Broadford and north of the River, mining is also being carried on to a limited extent on the Barnes property.

The workings here are now underground, on a slope following the dip of the beds. The product, about 500 tons a year, is ground for land plaster, and is of high grade, as shown by the following analysis by Prof. M. B. Hardin:

Calcium Sulphate	78.60 per cent.
Water	20.79 " "
Calcium Carbonate.....	.21 " "
Calcium Chloride	trace
Magnesium Chloride	trace
Organic .....	.12 " "
Silica, Oxide of Iron and Alumina .....	.23 " "
	99.95 " "

At several other points openings have been made at various times, but the lack of marketing facilities in the greater part of the belt has prevented any very extensive development.

HEMATITE: *Red Hematite. Iron Sesquioxide. Fe₂O₃.*

Specific Gravity, 4.9-5.3. Hardness of Crystals, 5.5-6.5. Occasionally found as tabular crystals, but more usually in the massive granular form; also botryoidal, stalactitic, micaceous or earthy. Color, steel-gray to iron black, giving a red streak or powder. *See Iron Ores.*

HORNBLLENDE: *See Amphibole.*

ILMINITE: *Menaccanite. Titanic Iron Ore. FeO. TiO₂.*

Specific Gravity, 4.5-5. Hardness, 5-6. Crystals, tabular, resembling specular iron. Often found in thin plates or seams in quartz; also in grains and massive. Color, iron black. Streak and powder, red to black. Lustre submetallic. Occurs in large quantities in Bedford County near Forest Station, Norfolk & Western Railroad, also near Midway Mills, Nelson County.

IRON ORES: The four varieties of ore used in iron manufacture are: Magnetite or Magnetic Ore. Specular Ore or Red Hematite, Limonite or Brown Hematite, and Spathic Ore (Carbonate of Iron.) All of these varieties are found in the iron ore region of

Virginia, the first three in great abundance. The various deposits occur in several well defined belts, the most easterly of which includes the limonite or "gossan ore" overlying the pyrites and gold bearing veins in Spottsylvania, Orange, Louisa, and the eastern edge of Buckingham County; also the belt of magnetic and specular ores in the eastern part of Buckingham and western edge of Cumberland Counties.

The first iron furnaces erected in Virginia were on this belt, and used the "gossan" ore overlying the pyrite deposits, until about 1879, when the pits had reached a depth at which the ore became too highly contaminated with sulphur to produce good iron. The ores were of excellent quality, averaging about 52 per cent. iron, and very free from phosphorous, titanium and manganese. While these gossan deposits have been worked down to pyrites at many points, there are many localities along the belt where much good ore is still available.

The deposits of magnetic and specular ore on this belt in Cumberland are worthy of attention. These ores are apparently quite distinct from the limonite deposits derived from the pyrites veins. They are found in several well defined leads, the most important of which runs from near the eastern flank of Willis' Mountain, close to, and in the same direction as the Buckingham-Cumberland County line. A few miles further west a second lead occurs, showing much fine ore in various openings.

The next iron ore belt is that of the Middle James River. This belt extends from Albemarle County through Nelson, Buckingham, (western edge) Amherst, Appomattox, Campbell, Pittsylvania and Henry Counties. The ores consist of limonite, micaceous specular ore, red hematite, and, in Campbell, Pittsylvania and Henry Counties, of magnetite. They are all very low in phosphorous and manganese and with the exception of the magnetites, are free from titanium.

The part of this belt which has been most extensively worked is that traversed by the James River from the neighborhood of Howardsville to within a few miles of Lynchburg—a distance of about thirty-five miles in a direct line.

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These beds of limonite supplied most of the ore used in the James River Valley furnaces in earlier days, and were extensively mined at Norwood, Greenwood, Elk Creek, Christian's Creek, and Stonewall Creek.

The red hematite and magnetite deposits have furnished a large quantity of ore of excellent quality. At Greenway the vein is from two to six feet thick and is practically continuous for a distance of nearly ten miles. Other points at which the specular hematite has been largely mined are Stapleton, Riverville and Mount Athos.

The following analyses made in this laboratory show the composition of average samples of the ores from the points mentioned:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.
	Per ct.	Per ct.	P r ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Silica	14.70	16.94	5.04	4.13	2.64	2.96	5.91	11.41
Ferric Oxide.....	73.53	73.37	93.05	92.25	95.77	94.15	90.01	82.41
Manganese Oxide	1.05	.08	.13	.09		.13	.05	.19
Alumina	4.64	4.93	1.23	.94		.61	2.01	2.46
Lime (CaO).....	.14	.07	.05	.06	.28	.31	.03	1.16
Magnesia (MgO)..	.26	.04	.06	.07		.13	.02	.23
Titanic Acid.....						.96		.29
Sulphuric Acid...	.03	.13	.07	.09			.13	
Phosphoric Acid.	.402	.97	.066	.082	.71	.112	.238	.67
Water.....	5.14	3.51	.71	.93	.56	.68	1.71	1.14
	99.892	100.000	100.000	99.642	99.96	100.042	100.008	99.96

- No. 1. Sleepy Hollow tract, Norwood, Nelson County—brown hematite.
- No. 2. Stonewall, Riverville, Nelson County—brown hematite.
- No. 3. Harris Vein No. 1, Greenway, Nelson County—specular hematite.
- No. 4. Vein No. 16, Greenway, Nelson County—specular hematite.
- No. 5. Vein No. 6½, Riverville, Nelson County.
- No. 6. Vein No. 6, Riverville, Nelson County.
- No. 7. Maud Vein, Stapleton, Amherst County.
- No. 8. Wingfield Ore Vein No. 11—Stapleton.

Southwest of Mount Athos, the ores are specular hematites largely mixed with magnetite. They contain 58 per cent. to 65 per cent. metallic iron and from a trace to .05 per cent. phosphorous.

A continuation of this belt runs through the northwestern part of Pittsylvania County into Henry County. In Pittsylvania, the high grade steel ores have been extensively mined in the neighborhood of Pittsville. In Henry and Patrick Counties many deposits of true magnetite occur.

The next westerly iron ore belt is that of the Valley of Vir-

ginia extending from the Potomac on the northeast to the Tennessee line in the Southwest—a distance of 330 miles.

The Blue Ridge and its extensions in southwest Virginia, form the eastern boundary of the Valley, while on the western side, are the North and Brushy Mountains, of which the extensions in the southwest are known by various local names. The iron ores occur along both of these ranges in the Primal or Potsdam sandstone, and Lower Silurian Limestone formations. These are the ores which have been the great source of supply of all cold blast furnaces of the Valley of Virginia and Southwest Virginia, and which now supply the furnaces at Milnes, Gosheu, Longdale, Lowmoor, (in part), Iron Gate, Buena Vista, Roanoke, Salem, Pulaski, Ivanhoe, Graham, Kayoulah, Max Meadows and Rural Retreat.

The varieties found are red and brown hematites, and, at the southern extremity of the Valley, some magnetite. In the lower part of the Potsdam Sandstone formation occur series of slates, which carry a red hematite—the specular iron ore of the Blue Ridge. This ore has been extensively developed in Botetourt, Bedford, Bockbridge and Augusta Counties.

In the more northern Counties the beds are usually too lean for profitable working, but in those Counties above mentioned, particularly in Botetourt and Bedford, beds varying from two feet to four feet in thickness, are found over large areas, yielding ore, the composition of which is indicated by the following analyses:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Metallic Iron.....	43.14	47.75	42.19	42.75	40.24	43.30
Metallic Manganese..	.03		.02		.03	
Phosphorous .....	.258	.314	.240	.076	.272	.468
Sulphur .....	.02		.02		.02	
Silica.....	33.46	18.63	34.81	25.00	35.65	30.54

No. 1.	From the Glenwood Estate	Analyst—	Dr. Henry Froehling
No. 2.	“ “ “ “	“	Prof. A. S. McCreath
No. 3.	“ “ Cloverdale Mine	“	Dr. Henry Froehling
No. 4.	“ “ “ “	“	Prof. A. S. McCreath
No. 5.	“ “ Arcadia “	“	Dr. Henry Froehling
No. 6.	“ “ “ “	“	Prof. A. S. McCreath

Above these slates, in the Potsdam Sandstone itself, occurs a bed of iron ore, high in phosphorous, and, when used by itself, giving a cold short pig iron. This ore is limonite, generally hard, compact, and brittle. It is mined in Rockbridge County near Vesuvius Station, on the Buena Vista property, and opened on the Glenwood estate.

The following analyses are typical of its composition:

	No. 1.	No. 2.	No. 3.
Silica	7.95 per cent.	8.46 per cent.	6.12 per cent.
Metallic Iron.....	53.22 " "	52.12 " "	55.63 " "
Metallic Manganese .....	.32 " "	.27 " "	.19 " "
Sulphur.....			
Phosphorus	1.233 " "	1.372 " "	1.105 " "
Sample No. 1. Ore from Cold Short Bank Vesuvius	Analyst—Prof. A. S. McCreath		
“ No. 2. “ “ Buena Vista property	“ Dr. Henry Froehling		
“ No. 3. “ “ Glenwood Estate	“ “ “ “		

The source, however, of the iron ore used in the old charcoal furnaces of the Valley of Virginia and of the new coke furnaces, is in the upper slates of the Potsdam Sandstone formation, lying immediately below the bottom of the magnesian limestone. From Page County to Roanoke County, these beds have yielded, and will continue to yield large quantities of brown hematite ores, of excellent quality. The following analyses, made in this laboratory, of the ores from the various parts of this formation show their character:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Metallic Iron.....	52.33	51.06	54.61	59.65	56.11	56.35	56.75	52.11
Metallic Manganese	2.84	1.94	3.26	.13		.23	.08	0.94
Phosphorus .....	.183	.143	.161	.198	.368	.112	.513	.193
Silica	6.86	8.12	5.92	3.19	4.28	6.47	4.96	9.95

No. 1. Ore from Milne's Iron Ore Bank—Lump Ore.
No. 2. “ “ “ “ Wash Ore.
No. 3. “ “ Cornella Mine, Luray Station—Lump.
No. 4. “ “ Buena Vista property—Big Workings.
No. 5. “ “ “ “ 90 ft. vein.
No. 6. “ “ Purgatory Iron property near Buchanan—Lump Ore.
No. 7. “ “ Big Hill Iron property “ “
No. 8. “ “ Blue Ridge Mine near Blue Ridge Springs.

Overlying the limonite of the upper Potsdam Slates, important beds of red and brown hematite and magnetic iron ore are found in the Magnesian Limestone formation, constituting the ores of the Valley Limestones. The ores of this formation have

not been greatly developed in the northern portion of the Valley, but the extensive deposits of soft limonite occurring throughout the southwest Counties, particularly in Wythe, Pulaski and Smyth, constitute the source of most of the ore used in the cold blast charcoal furnaces of that region. All three kinds of ore found are of exceptional purity, and very uniform in composition over large areas. The following analyses show the composition of the samples of each kind of ore:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Metallic Iron.....	63.550	70.24	61.00	59.15	55.00	53.04
Phosphorous.....	.151		.028	.0.9	.24	.12
Sulphur.....	.002	.02			.16	.06
Silica.....	5.210	1.83	7.61	7.8	5.76	8.53
No. 1. Magnetite, near Pearisburg, Giles County				Analyst—Prof. A. S. McCreath		
No. 2. " " " "				" " F. A. Genth		
No. 3. Red Hematite Newport, " "				" " A. S. McCreath		
No. 4. " " Abingdon, Wash. "				" " "		
No. 5. Limonite, Fishersville Augusta "				" " J. W. Mallet		
No. 6. " Bland Courthouse. Bland "				" Froehling & Rober son		

Two more important varieties occur in the Valley belt, namely the red hematites found in the shales of the No. 5 or Clinton formation, and the limonites of the Oriskany Sandstone or No. 7 formation.

The hematites of the Clinton group are, in the upper beds, usually shaly in character and deep red in color, and are known as "red shale ores," while the lower beds are frequently fossiliferous, constituting the "fossil ores." Large exposures of these ores are found on Purgatory and May's Mountains, near Eagle Rock on North Mountain, on the Rich Patch property near Covington, and in Fort Valley of the Massanutton Range, a bed nearly thirty feet thick is said to have been proven over a considerable area. The ores usually have a soft slaty structure and are almost always of very superior quality.

The following analyses by us show the composition of average samples from different points:

	No. 1.	No. 2.	No. 3.	No. 4.
Metallic Iron..	55.20 per cent.	47.60 per cent.	57.63 per cent.	56.49 per cent.
Phosphorous..	.42 " "	.489 " "	.422 " "	.031 " "
Silica	2.06 " "	18.66 " "	6.40 " "	15.96 " "

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- No. 1. Red Shale Ore. Sheet property, Eagle Rock.
- No. 2. " " " North Side Purgatory Mountain.
- No. 3. " " " Iron Gate mines, Alleghany County.
- No. 4. " " " Middle ridge between North and Catawba Mountains.

The brown hematite beds of the Oriskany Sandstone or No. 7, formation, constitute in respect of quantity and quality, one of the most important sources of iron ore in Virginia.

Lowmoor and Longdale furnaces draw their chief supplies from this horizon, and produce from it a particularly soft and strong foundry iron.

Long continued and extensive mining operations on the numerous beds of this ore, particularly at the Longdale, Lowmoor, Glen Wilton and other mines in the Rich Patch region, have fully proven the thickness and continuity of the stratum, and the regularity of its composition has been thoroughly demonstrated by the excellent character of the iron produced from it at various furnaces.

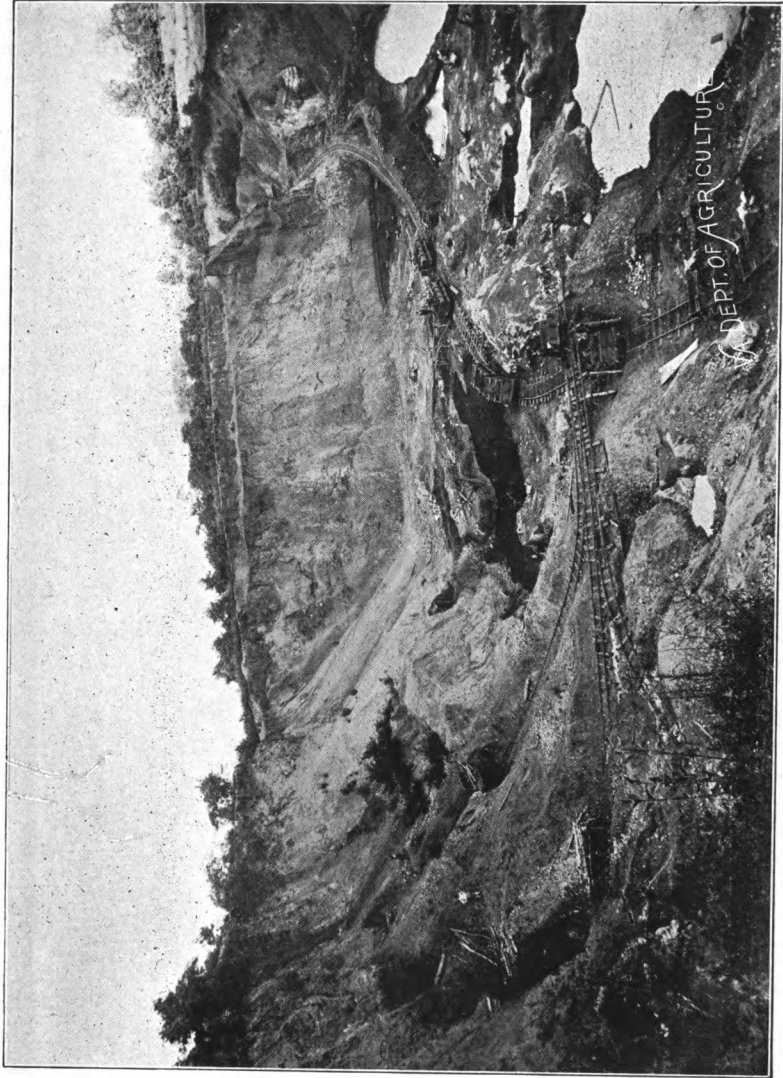
The deposits have been most extensively developed on Rich Patch Mountains, at Eagle Rock, Catawba Creek, Iron Gate, Craigs Creek, Potts' Creek and John's Creek.

The following series of analyses made in this laboratory, of average samples from openings at various points on this formation, show the composition of the ore:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Metallic Iron	56.77 Per Ct.	59.64 Per Ct.	51.97 Per Ct.	51.28 Per Ct.	51.60 Per Ct.
Phosphorous	.504 " "	.482 " "	.176 " "	.616 " "	2.93 " "
Silica	4.96 " "	2.46 " "	7.26 " "	11.09 " "	9.20 " "
			No. 6.	No. 7.	No. 8.
Metallic Iron	.....	.....	52.26 Per Ct.	41.23 Per Ct.	53.64 Per Ct.
Phosphorous	.....	.....	121 " "	.342 " "	.401 " "
Silica	.....	.....	8.93 " "	11.21 " "	9.10 " "

- No. 1. From Big Hill, Botetourt County.
- No. 2. " Peake's property, Eagle Rock.
- No. 3. " Ore Bed supplying Catawba Furnace.
- No. 4. " Roaring Run property, Botetourt County.
- No. 5. " Glen Wilton Mines " "
- No. 6. " Craigs Creek Botetourt County.
- No. 7. " Potts' Creek, Craig County.
- No. 8. " John's Creek, near New Castle Craig County.

The following table of analyses of the ores from the numerous mines of the Virginia Iron Coal and Coke Company



IRON ORE MINE, WYTHE COUNTY.

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TILDEN FOUNDATIONS.**

MINERALS AND MINERAL RESOURCES OF VIRGINIA. 63

shows the average composition of the deposits being extensively worked in Botetourt and the southwestern Counties of the State.

MINE.	POSTOFFICE.	METALLIC IRON.	PHOSPHORUS.	MANGAN- ESE.	SILICA.	ANNUAL OUTPUT TONS.
Ben Hur.....	Lee County	40.00	.25	.13	30.76	12000
	Ben Hur					
Barren springs	Wythe County	52.66	.13	.17	10 88	24000
	Barren Springs					
Cedar Run.....	Wythe County	51.57	.19	.76	11.80	12000
	Buddle.....					
Crawford	Wythe County	49.39	.13	1.00	14.25	8000
	Patterson					
Dewey.....	Bedford County . .	42.18	.29	.09	29 34	40000
	Blue Ridge Springs					
Edith Iron Mines	Botetourt County	38.65	.30	.19	18.80	16000
	Blue Ridge Springs					
Foster Falls.....	Wythe County	43.38	.31	2.79	12.98	16000
	Foster Falls.....					
Grubb Mines.....	Botetourt County	43.96	1.01	1.18	9.26	20000
	Blue Ridge Springs					
Hematite Mines	Wythe County	49.75	.14	1.12	13.47	6000
	Foster Falls.....					
Hurst Mines	Wythe County	45.67	.18	1.50	16.20	3500
	Reed Island					
Ironville Mines..	Bedford County ...	38.00	.37	.12	36 84	7000
	Blue Ridge Springs					
Little Wythe	Wythe County	51.77	.12	.54	9.79	10000
	Cripple Creek.....					
Locust Hill	Wythe County	44.22	.40	.89	15.98	15000
	Max Meadows ...					
Posey Mines	Wythe County ...	51 40	.12	.84	11.68	7000
	Foster Falls					
Rich Hill	Pulaski County....	51.20	.12	.47	13.88	22000
	Allisonia					
Reed Island	Pulaski County ...	52.22	.12	.29	12.95	17000
	Reed Island					
Rorer Mines	Roanoke County ..	48.50	.37	.87	15.18	30000
	Roanoke					
Sanders Mine	Wythe County	54.22	.10	.19	7.53	20000
	Foster Falls					
Swecker Mines ..	Wythe County	45.17	.12	.47	18.10	16000
	Barren Springs					
Walton Mines. ...	Wythe County	50.80	.13	.64	11.10	15000
	Foster Falls.....					

JASPER: *A variety of Quartz, SiO₂.*

Color, yellowish-brown, reddish-brown. Occurs in epidotic rocks of the Blue Ridge in several localities, particularly at Thornton's Gap.

KAOLINITE: *Kaolin. Hydrated-Aluminium Silicate (Al₂O₃. 2 SiO₂. 2 H₂O).*

Specific Gravity, 2.6-2.65. Hardness, 2-2.5. Occurs in clay-

like masses, generally white or slightly tinted gray or yellowish. Kaolin is the name applied to the clay resulting from the decomposition of feldspar, which decomposition consists principally in the removal of the alkali (potash) with part of the silica, and the addition of water. It is used in the manufacture of the better grades of porcelain ware, and as a filler in the manufacture of paper.

Kaolin is widely distributed in Virginia. It occurs in extensive beds on the edge of granite region, where it has been derived from the decomposition of this rock. *See Clays.*

LAMPADITE: *Cuprous Manganese. Bog Manganese (Wad) containing Copper.*

Locality, Howardsville, Albemarle County.

LIGNITE: Thin seams of lignite are met with in the soft sandstones of the upper secondary strata, particularly in the neighborhood of Taylorsville, Hanover County, but no deposits of any economic importance are known.

LIMESTONE: The limestone deposits of the State are of great extent and importance. They include an unlimited amount of building stone of various varieties, from that suitable for general building purposes to fine ornamental marbles, an abundant store of stone for flux, in close proximity to the iron ore beds, and many high grade deposits from which the best quality of lime for architectural and agricultural purposes is produced.

The deposits are found in two of the geological horizons—the No. 2 or Great Magnesian Limestone, and No. 6 or Lower Helderberg Limestone formations. The former underlies almost the entire Valley of Virginia, with frequent exposures, particularly in the upper end and along the James River, while thick beds of the lower Helderberg limestone are exposed at numerous points on the high ridges of the middle and southwestern parts of the Valley.

The beds occurring in the Magnesian Limestone formation are characterized by a high percentage of magnesia, and at some points are true dolomites. Dolomite is used in the manufacture

of refractory lining for furnaces employed in the manufacture of steel by the basic process. Magnesian limestone has also a limited use as a hydraulic cement after calcination. Its use for building purposes, however, is the most important, and many fine exposures of the massive close grained varieties are found throughout the Valley. Though a high percentage of magnesia is a characteristic of the limestone of this formation, deposits occur at numerous points, containing only traces or small amounts of this ingredient, and which consequently are well suited for flux, and the manufacture of agricultural and building lime.

In the upper part of the Valley, at Strasburg in Shenandoah County, an important deposit is being very extensively worked by the Powhatan Lime Company. The rock at this point is of exceptional purity, as is shown by the following series of analyses made by us, of representative samples:

	No. 1.	No. 2.	No. 3.
Calcium Carbonate	98.71 per cent.	98.93 per cent.	97.98 per cent.
Magnesium Carbonate.....	.65 " "	.61 " "	.72 " "
Silica . . . . .	.25 " "	.18 " "	.74 " "
Oxide of Iron and Alumina..	.31 " "	.22 " "	.29 " "
Organic matter, etc.	trace	trace	.16 " "
	<u>99.93</u> " "	<u>99.94</u> " "	<u>99.89</u> " "

This rock, as might be expected, produces an architectural lime of the highest grade. Three kilns are at present in operation, producing 360 barrels of lime per day, and three additional kilns are now completed and ready for firing, which will increase the daily output to 720 barrels. On the same property there is a large deposit of argillaceous limestone excellently suited for the manufacture of Portland Cement.

The deposit has been thoroughly proven by numerous core-drillings to a depth of over 80 feet, and more than fifty analyses made in this laboratory, of the samples of the core taken at every five feet, have shown that the material has all the characteristics of high grade cement rock, and closely approximates the composition of the well known cement rock of the Lehigh Valley.

The following series of analyses, published by permission, shows its composition at various points and depths, and for com

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parison, analyses of the Lehigh Valley rock, and of a typical cement mixture before burning, are included:

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.	No. 4 Per cent.	No. 5. Per cent.
Silica	11.70	13.26	10.20	10.84	14.58
Alumina	6.50	7.22	5.02	2.62	4.94
Oxide of Iron.....	1.52	1.76	1.40	1.26	1.42
Calcium Carbonate	75.76	73.40	76.14	81.00	73.37
Magnesium Carbonate	1.27	1.55	1.06	2.27	2.73
Calcium Sulphate	—	—	—	—	—
Water and Organic matter	2.96	2.62	4.30	1.49	2.74
	<u>99.70</u>	<u>99.81</u>	<u>99.88</u>	<u>99.50</u>	<u>99.78</u>

	No. 6. Per cent.	No. 7. Per cent.	LEHIGH CEMENT ROCK. Per cent.	LEHIGH CEMENT MIXTURE. Per cent.
Silica	11.24	15.99	15.40	13.20
Alumina	4.20	6.22	4.26	4.20
Oxide of Iron.....	1.40	1.32	1.38	1.12
Calcium Carbonate	77.56	71.84	74.66	77.10
Magnesium Carbonate.....	3.01	3.06	2.66	3.80.
Calcium Sulphate	—	—	.86	—
Water and Organic matter	2.36	1.38	0.78	.86
	<u>99.77</u>	<u>99.81</u>	<u>100.00</u>	<u>100.00</u>

At Harper's Ferry an exposure of limestone very free from magnesia is shown and has been developed to some extent for lime. An analysis of a sample from this point is given by Prof. W. B. Rogers, as follows:

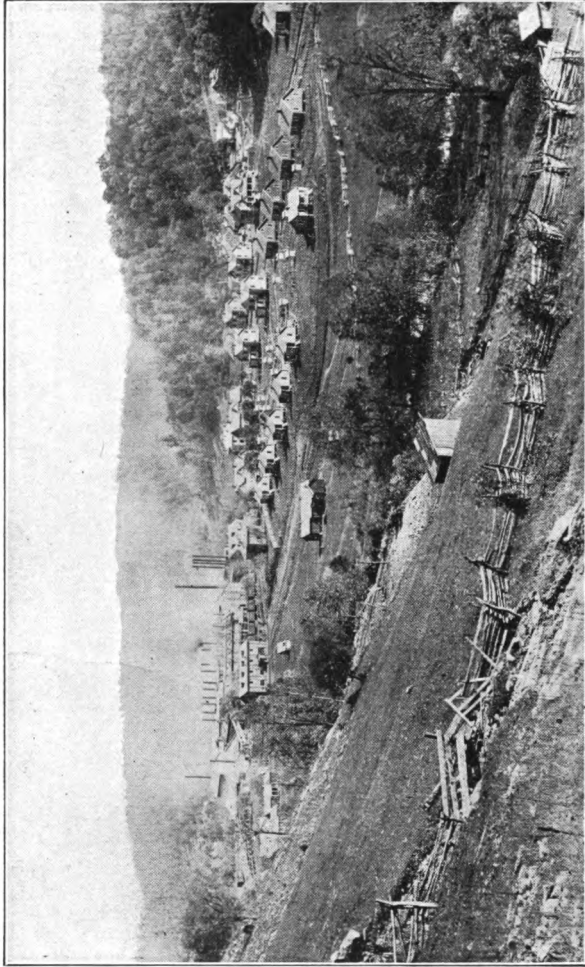
Calcium Carbonate.....	95.86 per cent.
Magnesium Carbonate..	1.46 " "
Silica	1.83 " "
Oxide of Iron and Alumina.....	— " "
Water and Loss .....	.85 " "
	<u>100.00</u> " "

At Riverton, Warren County, on the forks of the Shenandoah River another deposit of limestone of great purity is found, of which an analysis gave the following result:

Calcium Carbonate.....	97.98 per cent.
Magnesium Carbonate .....	.54 " "
Oxide of Iron and Alumina.....	.19 " "
Silica .....	.43 " "
Organic Matter and Loss..	.73 " "
	<u>99.87</u> " "

This limestone has been burnt for lime for many years, yielding a product of very high grade, which has an extensive sale throughout the State.

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THE VIRGINIA PORTLAND CEMENT WORKS, CRAIGSVILLE, AUGUSTA COUNTY

Similar deposits more or less free from magnesia, are found at various points in Rockingham, Augusta, and Rockbridge Counties, and have been slightly developed, furnishing lime for agricultural and building purposes. Prof. Rogers reports an occurrence of a dun-colored limestone half a mile west of New Market, which is quite free from magnesia. At Craigsville in Augusta County, there are important quarries, furnishing stone containing very little magnesia. The product of one of the quarries is used to a large extent in the manufacture of the well known "Old Dominion" brand of Portland cement. In the neighborhood of Staunton, Fishersville and other localities in the same county, lime-burning has been carried on to a small extent.

Along the mountain ridges separating Bath and Alleghany from Rockbridge and Botetourt Counties, as well as in various other localities in the two Counties last named, frequent exposures of the Lower Helderberg limestone are met with and some fine quarries in this and the Great Magnesian Limestone formation are being worked, which supply excellent limestone for lime-burning, and flux for the numerous furnaces of this region.

At Bell's Valley in the northwest corner of Rockbridge, the limestone from No. 6 formation is largely quarried as flux for the Victoria Furnace, and the furnaces at Lowmoor and Longdale also get their supplies from bluffs in the same formation.

Architectural lime is being made at several quarries from a very fine coralline limestone found extensively along the James River in Botetourt and Rockbridge Counties, conspicuous exposures being at Eagle Rock, Indian Rock and in the immediate vicinity of Lexington.

At the places above named the limestone is exceptionally pure and yields a building lime of the best quality.

At Eagle Rock it is being extensively worked by the Moore Lime Company, whose five kilns at this point produce 780 barrels of lime per day, while at Indian Rock large quantities are quarried for flux and lime-burning at Dillon's lime kilns.

The great purity of the deposits at these points is shown by the following analyses made in this laboratory:

	Moore Lime Co. Quarry Eagle Rock.	Peak Quarry Eagle Rock Av. of Quarry.	Dillon's Quar- ries Indian Rock, Flux.
Calcium Carbonate.....	98.641 per cent.	96.786 per cent.	92.857 per cent.
Magnesium Carbonate.....	.433 " "	.642 " "	1.362 " "
Oxide of Iron and Alumina	.306 " "	1.446 " "	3.013 " "
Silica.....	.273 " "	.750 " "	2.340 " "
Phosphoric Acid.....	.021 " "	.024 " "	.037 " "
Water and Organic Matter	.263 " "	.290 " "	2.50 " "
	99.937 " "	99.908 " "	99.829 " "

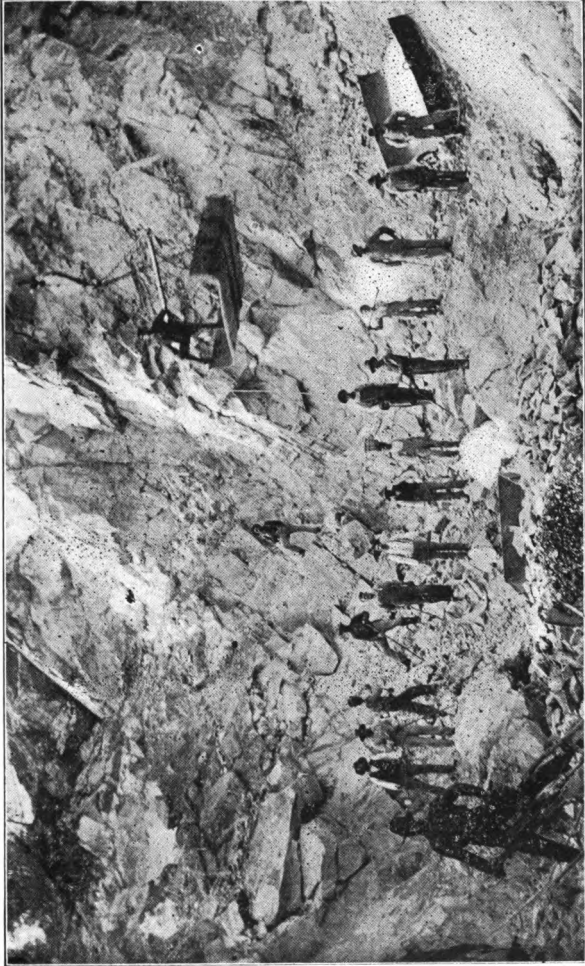
At Balcony Falls the magnesian limestone has been used for many years for the manufacture of hydraulic cement by the James River Cement Works. This cement was extensively used in building the dams and locks on the James River Canal:

The following is an analysis of the rock from near Glasgow, by Prof. Rogers:

Calcium Carbonate.....	57.87 per cent.
Magnesium Carbonate.....	82.90 " "
Silica.....	7.10 " "
Alumina and Oxide of Iron.....	.83 " "
Water.....	.27 " "
Organic Matter.....	1.03 " "
	100.00 " "

East of the Blue Ridge, the chief deposits are found in the belt of magnesian limestone running in a southwesterly direction through the eastern edge of Albemarle County and having its most prominent exposures along the James River iron ore belt, from Howardsville to Lynchburg, a distance by the River of about fifty miles.

The northern extremity of the belt appears to be near Keswick in Albemarle County, at which point lime has been burned for local use. Between this point and the beginning of the extensive ledges exposed along the River, there are only infrequent and unimportant outcrops, but from Howardsville on, the limestone is everywhere abundant. At several localities along the belt, the stone has the fine close grained characteristics of marble. The deposit of this kind at the mouth of Tye River has been referred to under "Building Stones."



LIMESTONE QUARRY OF MOORE LIME COMPANY, BOTETOURT COUNTY.

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The bulk of the limestone in this region is highly magnesian in character, but at several localities deposits are found which do not carry enough of this ingredient to prevent the stone being suitable for flux and for lime-burning. At these points quarries have been opened and developed to some extent.

Those near Norwood, Warminster, Greenway, Walker's Ford and Stonewall Creek have all furnished limestone for small lime-burning operations, the composition of which is shown in the following table of analyses:

	NORWO D.	WARMINSTER.	GREENWAY.	WALKER'S FORD.	STONEWALL CREEK.
	Per cent.	Per cent.	Per cent	Per cent	Per cent.
Calcium Carbonate.....	91.33	89.63	86.74	92.03	88.41
Magnesium Carbonate.....	2.41	3.87	5.63	4.13	8.81
Oxide of Iron and Alumina...	.50	1.12	1.32	.60	.83
Silica.....	5.54	5.07	5.91	3.10	1.68
Organic Matter, etc. ....	.22	.31	.40	.14	.27
	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>	<u>100.00</u>

At numerous other localities along the same belt stone for flux was quarried, while the iron furnaces in this region were in blast

The old Dean furnace at New Canton was supplied from beds two miles below Warminster, and the furnace at Elk Creek used a limestone occurring in the same vicinity of which the following is an analysis made by us:

Calcium Carbonate.....	83.77 per cent.
Magnesium Carbonate.....	3.01 " "
Oxide of Iron and Alumina.....	1.40 " "
Silica.....	11.01 " "
Water and Organic Matter.....	.71 " "
	<u>100.00 " "</u>

The flux used at the Lynchburg Furnace was obtained from a thick bed of limestone near the base of Mount Athos, which is said to contain about 92 per cent. Carbonate of Lime.

Southwest of Mount Athos occasional exposures of limestone are found on this belt; a quarry on Back Creek, northwest of

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Leesville, Campbell County, is reported by Prof. Rogers as yielding a compact light blue rock of the following composition:

Calcium Carbonate	92.76 per cent.
Magnesium Carbonate	2.44 " "
Oxide of Iron and Alumina .....	.56 " "
Silica	3.84 " "
Water and Loss .....	.40 " "
	100.00 " "

Both the Helderberg and Magnesian Limestones are frequently exposed throughout Southwest Virginia, and deposits are being worked at many places which supply flux for the iron furnaces at Roanoke, Radford, Graham, Pulaski, Ivanhoe, Kayoulah, Max Meadows, White Rock and Bristol, as well as lime kilns at Christiansburg and other localities.

A limestone of fine grain and uniform texture which has been used to a slight extent for lithographic stone, is found at Fincastle, Botetourt County.

LIMNITE: *Bog Iron Ore.*

Peters Creek, Craig County.

LIMONITE: *Brown Hematite, Hydrrous Ferric Oxide, 2 Fe₂O₃. 3H₂O.*

Specific Gravity, 3.6-4.0. Hardness, 5-5.5.

Usually occurs in massive form, but also botryoidal, stalactitic, concretionary or earthy. Color, various shades of brown, to ochre yellow.

This is the most abundant iron ore in Virginia. *See Iron Ores.*

MAGNESITE: *Magnesium Carbonate, Mg CO₃.*

Specific Gravity, 3-3.08. Hardness, 3.5-4.5. Lustre, vitreous. Color, white or yellowish. Occurs in thin seams in soapstone in Amelia County near Chula.

MAGNETITE: *Magnetic Iron Ore. Ferric and Ferrous Oxides, Fe₂O₃ FeO.*

Specific Gravity of crystals 5.16-5.18; when massive, 4.9-5.2. Hardness, 5.5-6.5. Crystals, octahedrons and dodecahedrons,

usually very perfect; also occurs massive granular to compact. Color and streak, iron black. Lustre, metallic to sub-metallic. Occurs extensively in the iron ore belts in two varieties:

1st. Ordinary Magnetite, very free from phosphorous, and containing practically no titanitic acid, and

2nd. Titanitic Magnetite, also very free from phosphorous, but containing considerable titanitic acid.

The deposits of the southwest continuation of the Middle James River iron ore belt in Campbell, Pittsylvania and Henry Counties belong to the first type, while the magnetites found in Patrick and Grayson Counties are frequently highly titaniferous. *See also Iron Ores.*

MALACHITE: *Green Copper Carbonate*, $2 \text{CuO} \cdot \text{CO}_2 \cdot \text{H}_2\text{O}$.

Specific Gravity, 3.7-4.01. Hardness, 3.5-4. Usually occurs in massive form or as encrustations. Structure, botryoidal or stalactitic, and often fibrous or banded. Color, light green. Streak, pale green. Occurs in most of the copper mines in Virginia. *See Copper Ores.*

MARCASITE: *White Iron Pyrites*. *Bisulphide of Iron*, FeS_2 .

Specific Gravity, 4.9. Hardness, 6-6.5. Crystallizes in low pyramids of the orthorhombic system, but is more common in stalactitic, botryoidal, or concretionary forms of a grayish yellow color. *See Pyrite.*

MANGANESE ORES: Deposits of manganese ore, including high grade oxides (pyrolusite and psilomelane) and manganiferous iron ore, occur widely distributed throughout the State, particularly along the James River Valley and the Valley of Virginia, and have been extensively developed at several points.

Of high grade ores, Virginia has for many years supplied the greater part of the total output of the United States, the most of it coming from the well known Crimora Mine, situated in Augusta County, about two miles east of Crimora Station. At this place a synclinal basin in the Potsdam Sandstone about 900 feet long by 500 feet in width, has been filled with the clay derived from the decomposition of the feriferous shales overlying the massive

sandstone. The manganese was originally disseminated through the rock and has become concentrated in the clay resulting from its decomposition. The ore which is psilomelane with a very little pyrolusite, is found irregularly distributed through the clay in nodular masses varying from pebble size to lumps a ton or more in weight.

The deposits have been developed by means of a shaft now considerably over 100 feet deep, with levels driven at 75 and 105 feet.

The maximum thickness of the ore-bearing clay is apparently about 300 feet. The ore is crushed, washed and screened to remove fines, and after drying is ready for shipment. The lump ore is mostly sent to England and the fines to Pittsburg. This mine has produced as high as 50 tons per day, during some years, of the highest grade of ore, the composition of which is shown by the following analysis:

COMPLETE ANALYSIS BY PROF. A. S. MCCREATH OF LUMP ORE.

Binoxide of Manganese	81.708	per cent.
Protoxide of Manganese	7.281	" "
Sesquioxide of Iron.....	.533	" "
Oxide of Cobalt .....	.354	" "
Oxide of Nickel .....	.096	" "
Oxide of Zinc .....	.823	" "
Oxide of Copper.....		
Alumina .....	.896	" "
Baryta .....	.829	" "
Lime .....	.880	" "
Magnesia .....	.630	" "
Sulphuric Acid.....		
Phosphoric Acid .....	.171	" "
Alkalis .....	.467	" "
Water	3.405	" "
Silica	2.132	" "
	<hr/>	
	100.00	" "

Metallic Manganese	57.291	per cent.
Metallic Iron .....	.373	" "
Phosphorous .....	.075	" "

As illustrating the high quality of regular shipments from this mine, the following analyses made in this laboratory, of samples of various foreign shipments are given:

	1.	2.	3.	4.	5.
Binoxide of Manganese	81.08 per ct.	84.04 per ct.	83.93 per ct.	79.43 per ct.	79.97 per ct.

At several other points in the James River Valley and Valley of Virginia, deposits have been opened and developed to some extent.

Near Norwood, on James River, about two miles from Midway Mills, a deposit of high grade manganese of much promise was opened some years ago, and fully 500 tons of ore of excellent quality was mined and shipped. The mine, however, was shut down, it is said, on account of insufficient equipment to handle the water, and has not been reopened. The ore produced contained about 58 per cent. metallic manganese, 1.5 per cent. iron and about .15 per cent. phosphorous.

In the same locality near Warminister, another deposit was opened about the same period and worked for a time, yielding a considerable quantity of ore very similar in character to that mined at Norwood. Further up the River, in the vicinity of Mount Athos, another deposit of good quality was mined to some extent.

At several other places on the southwest continuation of the Middle James River iron belt, through Campbell and Pittsylvania Counties, deposits of promise have been opened, but no development work has been done. One of the most recent openings near Hurt Station in Pittsylvania County has shown indications of a considerable deposit of high grade ore. From the large number of surface samples received by us from this belt, there are apparently numerous deposits along it worthy of investigation. A few miles southeast from Mount Athos, at Concord in Appomattox County, several openings have recently been made, and some good ore exposed.

The following are analyses of two samples received from these openings.

	No. 1.		No. 2.
Metallic Manganese.....	66.60 per cent	.....	52.92 per cent.
Metallic Iron.....	.28 " "	.....	2.53 " "
Phosphorous.....	.174 " "	.....	.002 " "
Silica.....	.99 " "	.....	10.53 " "

Deposits are also reported in the vicinity of Willis' Mountain, Buckingham County, and near Spiers Mountain, but only surface

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samples have been obtained from these localities. Undeveloped deposits are also reported from Albemarle and Orange Counties, but nothing is known regarding them.

In the northern part of the Valley of Virginia the manganese mined has been chiefly in the form of manganiferous iron ore, though deposits of high grade ore have been opened at a few points. In Page County manganiferous iron ore has been mined about three miles east of Milne's Station, and a promising deposit of high grade ore apparently of considerable extent, is found on the Garrison tract about two miles east of the railroad.

The following two analyses by Prof. A. S. McCreath, show the character of the ore:

	FINE ORE.		LUMP ORE.
Metallic Manganese.....	52.691 per cent.	.....	58.656 per cent.
Metallic Iron.....	2.325 " "	.....	1.537 " "
Phosphorous.....	.324 " "	.....	.327 " "
Silica.....	2.795 " "	.....	1.955 " "

In Rockingham County manganiferous iron ore of good quality for the manufacture of spiegel, has been opened on Big Run Creek.

In Augusta County the clays derived from the Potsdam Sandstone have yielded manganese at several places north and southwest of Crimora. North of Crimora a deposit was opened at Grottoes, yielding ore of good quality, as shown by the following analysis made by us:

Metallic Manganese.....	48.70 per cent.
Metallic Iron.....	2.29 " "
Silica.....	6.98 " "
Phosphorous.....	.40 " "

A few miles northeast of Elkton, an opening was made a few years ago, which gave promise of yielding much good ore, but so far as we know, has not been developed. A sample examined by us had the following composition:

Metallic Manganese.....	54.50 per cent.
Phosphorous.....	.18 " "

At and near Sherando a number of years ago, several hundred tons of high grade ore were taken out of open cuts, and while the work done was small, the results pointed to the existence of a large amount of ore in this locality.

At Lyndhurst Station deposits are also reported, and at Stuart's Draft Station, a few miles southwest of Lyndhurst, the Kennedy Mines produced a considerable amount of ore, the composition of which is shown by the following analysis by Prof. F. P. Dunnington:

Metallic Manganese	43.30 per cent.
Metallic Iron	3.88 " "
Silica	17.69 " "
Phosphorous .....	.052 " "

Continuing southwest, at Vesuvius, in Rockbridge County, a deposit of rich manganese was opened up, and a considerable amount of high grade ore was mined and shipped. At Midvale, in the same county, another deposit exists, from which some good ore was obtained, but nothing has been done for a few years.

In Botetourt County, a highly manganiferous iron ore has been extensively mined and shipped from the ore bank of the Houston Mines, one and a quarter miles from Houston Station. At places the bed contains almost pure manganese ore.

The following analyses by Prof. A. S. McCreath show the composition of the manganiferous iron ore and of selected manganese ore:

	MANGANIFEROUS IRON ORE.		MANGANESE ORE.
Metallic Manganese	24.710 per cent.	.....	59.87 per cent.
Metallic Iron	29.110 " "	.....	.500 " "
Phosphorous .....	.138 " "	.....	.049 " "
Silica	7.770 " "	.....	2.300 " "

In other parts of this county prospecting has been carried on, and small amounts of ore taken out at different places, but no deposits of consequence have yet been found.

In Roanoke County considerable work was done some years ago, a few miles southeast of Roanoke, and some high grade manganese ore was found.

Occurrences of manganese and manganiferous iron ore are reported from the southwestern counties of the State. In Lick and Draper Mountains, Wythe County, Flat Top Mountain near Bland County line, and in the mountains in the western part of Bland, considerable surface work has been done, and some promis-

ing ore has been exposed, but the development has not been enough to determine the quantity of any of the deposits.

In Smyth County, near Marion, the Stalie's Creek Manganese-Iron Company have recently opened a bed of high grade psilomelane, and are developing same.

A sample of the ore analyzed by us had the following composition:

Metallic Manganese	55.80 per cent.
Metallic Iron	5.05 " "
Phosphorous .....	.047 " "
Silica	9.93 " "

Many other surface samples received from the southwest, indicate the occurrence of deposits over a large area, the extent and value of which can only be determined by further development.

MARL: Extensive and valuable deposits of Miocene or "Calcareous" marl, and Eocene or "green sand" marl are found all over the Tertiary region, large exposures being visible more or less continuously along the banks of the Potomac, Rappahannock, Mattaponi, Pamunkey, York and James Rivers.

The Miocene marl district includes all the area from the coast to, roughly speaking, a hypothetical line running north and south through Coggins' Point on the James. From this hypothetical line to another passing from the mouth of Acquia Creek, through City Point on the James, and continuing south, the Eocene marl formation is largely exposed, with the Miocene overlying it at points.

The different varieties of Miocene marl found are white or yellow, blue, and brownish in color. The white or yellow varieties are richest in Carbonate of Lime, as a rule containing 80 per cent. and upward of this ingredient.

The blue colored marl is usually much more clayey than the white—the color generally being due to organic matter, though occasionally a considerable amount of "green sand" is found in it.

The brownish or reddish marls are of less importance, being usually composed of sandy clay, and often in hard masses which cannot be broken easily.

The great benefit derived from the use of the marls in agriculture is well known, and the beds are worked in many localities in the tidewater region for local use.

The white and yellow marl is generally very suitable for the manufacture of Portland Cement. An abundance of suitable clay—the other necessary raw material, is everywhere at hand, and coal can be obtained at a moderate rate from the great coal fields of Southwest Virginia. Under these conditions several localities on James River present exceptional opportunities for the establishment of a Portland Cement plant on tidewater.

The Eocene marl is of great value as a fertilizer on account of the large amount of “greensand” which it frequently contains.
See Glauconite.

MARTITE: *Isometric form of Hematite. Ferric Oxide. Fe₂O₃.*

Specific Gravity, 4.809-4.832. Hardness, 6-7. Crystallizes in octahedrons like magnetite, from which it is considered to be derived by oxidation. Lustre, submetallic. Color, iron black, with sometimes a bronze tarnish. Streak, reddish-brown or purplish-brown. Fracture, conchoidal. Is not magnetic or only slightly so.

MELACONITE: *Black Copper. Cupric Oxide. CuO.*

Specific Gravity, 5.9—6.25. Occurs in two varieties. Most commonly as dull black earthy masses, which soil the fingers, but sometimes as steel-gray metallic scales. In the massive form it is found in several copper deposits in Buckingham County, particularly that of the Q. Q. Copper Mining Company near Dillwyn.
See Copper Ores.

MELANITE: *A variety of Andradite. Calcium-iron Garnet.*
See Garnet.

MENACCANITE: *See Ilminite:*

METEORIC IRON: Four finds of meteorites have been recorded from different parts of the State, namely:

1. Meteoric Stone, which fell in Chesterfield County, June 4th, 1828.

2. Meteoric Iron found in Roanoke County.
3. Meteoric Iron found in Grayson County.
4. Meteoric Iron—four separate pieces found in the neighborhood of Staunton, Augusta County.

The four pieces from the neighborhood of Staunton are all so similar in composition that they evidently represent different portions of the same fall. The analyses of the four pieces made in the laboratory of the University of Virginia, are reported by Prof. J. W. Mallet, as follows:

	No. 1.	No. 2.	No. 3.	No. 4.
Iron	88.706 per cent.	88.365 per cent.	89.007 per cent.	91.439 per cent.
Nickel	10.163 " "	10.242 " "	9.964 " "	7.559 " "
Cobalt .....	.396 " "	.428 " "	.387 " "	.608 " "
Copper .....	.003 " "	.004 " "	.003 " "	.021 " "
Tin .....	.002 " "	.102 " "	.003 " "	trace
Phosphorous .....	.341 " "	.362 " "	.375 " "	.063 " "
Sulphur .....	.019 " "	.008 " "	.026 " "	.018 " "
Chlorine .....	.003 " "	.002 " "	.004 " "	trace
Carbon .....	.172 " "	.185 " "	.122 " "	.142 " "
Silicon (as Silica) .....	.067 " "	.061 " "	.056 " "	.108 " "
	99.872 " "	99.659 " "	99.947 " "	99.963 " "

MICA: *Muscovite. Potash Mica. Common Mica. Aluminium. Potassium Silicate.* $K_2O, Al_3(SiO_4)_3$.

Specific Gravity, 2.75—3.1. Hardness, 2-2.5. Crystals, six-sided, tabular. Cleavage, perfect, yielding easily thin elastic laminae of extreme tenuity. Found usually in thin foliated plates or scales. Color, white to colorless, gray, yellow, brown, violet or greenish. Lustre, vitreous.

Muscovite is practically the only variety of mica which has been mined in Virginia. It is widely distributed throughout the State east of the Blue Ridge, as a constituent of many crystalline rocks. It is only, however, when the crystals or plates are found of sufficient size to be cut into sheets, one by one and one-half inches, and upward, that it becomes an article of commercial value. Deposits of commercial mica occur in the crystalline belt of Virginia in veins or dikes of pegmatite, in Caroline, Spottsylvania, Hanover, Goochland, Powhatan, Buckingham, Prince Edward and Amelia Counties.

These pegmatitic dikes vary in thickness from a few inches to many feet, and run parallel to the schistosity of the accompanying rocks, or cross these at varying angles. As a rule the dikes or veins, in which the feldspar and quartz have crystallized out in large masses, are found to yield the best mica.

Small veins, therefore, do not give promise of commercial mica, as the crystals are usually too small to be of value.

The pegmatite in one of the mines in Amelia County, when fully exposed, had the exact appearance of granite, magnified about a thousand times. This mine, the Rutherford, yielded blocks of muscovite 18 x 23 inches and 12 inches thick, masses of quartz and blocks of feldspar weighing $\frac{3}{4}$ to 1 ton, and nearly all the crystallized minerals found accompanying mica.

The distribution of the mica in the vein is various. Sometimes, as in the Rutherford Mine, it is fairly evenly distributed; at others, the center of the vein is nearly barren and the blocks of mica are found near the walls. The blocks are of all sizes, from 3 inches in diameter to, in one instance in the Jefferson Mine, near Amelia Courthouse, 4 feet 6 inches, yielding a sheet over three feet long and nearly as wide. In thickness they vary from one inch to eighteen inches and over.

No mica has ever been found superior to that mined at Amelia Courthouse and at the mica mine near Hewletts, Hanover County. This latter mine has not been worked since 1872, yet the scrap mica found lying about the place is as sound and tough as the best mica found elsewhere.

The demand for mica has very much increased in late years, on account of its extensive use in the electrical industry. Much of this demand is supplied by imports from India, and there seems no reason why mica mining should not become a flourishing industry in Virginia.

The minerals found, in the Rutherford Mine, Amelia County, in addition to the muscovite and biotite mica were:

Quartz, Crystals—(some perfect: large white and smoky varieties.)

Amethyst—massive.

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Feldspar—Albite, Oligoclase, Orthoclase, Microcline, Amazon Stone.

Apatite—Perfect Crystals.

Allanite—Orthite.

Actinolite.

Autunite.

Beryl—(some gems of Beryl crystals; also large Beryls with perfect terminals.)

Cyanite.

Cassiterite.

Chabazite.

Columbite.

Enstatite.

Epidote.

Garnets.

Graphite.

Hematite.

Limonite.

Magnetite.

Menaccanite.

Molybdenite.

Microlite.

Monazite.

Pyrite.

Pyrrhotite.

Phosphuranylite.

Rutile.

Samarskite.

Tiurgstite.

Uranite.

Wolframite.

Zircon.

Zoisite—(Variety, rose-red Thulite.)

MILLSTONES, GRINDSTONES AND WHETSTONES. Two kinds of stone are employed in milling practice, the one, a tough cellular flinty rock called buhrstone, and the other, a conglomerate composed of quartz pebbles imbedded in a hard silicious cement. Both of these varieties of stone are found in considerable quantity in several Counties of the State. Good specimens of buhrstone have been obtained from the neighborhood of Martinsville, Henry County, along Walker's Mountain, Bland County, and near the southern boundary of Montgomery County.

The Montgomery buhr varies in color from yellowish white to orange brown, possesses a uniform cellular texture and very hard and sharp grit.

A silicious conglomerate known locally as pebbled millstone grit occurs in large quantities along the south side of Brush Mountain, Montgomery County, and is especially adapted for milling purposes.

A coarse conglomerate with a very sharp hard grit is found in large quantities in Massanutten Mountain in the upper end of the Valley, and was at one time extensively used for millstones.

A sienitic granite which used to be quarried for millstones, occurs in large masses outcropping for some distance along the river near Collin's Ferry.

GRINDSTONES. The sandstones of the Carboniferous age furnish most of the grindstones now used, and this formation is represented in Virginia in the extensive exposures of the Vespertine Gray Sandstone in Montgomery, Wythe, Pulaski and Bland Counties.

The fine hard grained variety of this sandstone found at various points along Brush Mountain, has been used to a considerable extent locally for millstones, for which purpose it is admirably adapted. Along the foothills of the Pilot Range, on the north side of the Mountain, there is an extensive deposit of this character found partly in boulder and slab form and partly in fine powder. Within the past few years slabs of very fine even grain from this locality were marketed for whetstones, and the powder for polishing purposes.

It is difficult to find any extensive body of sandstone possessing the requisite qualities of fine regular grain, hardness sufficient for strength but not enough to prevent steady crumbling away under friction, so that the production of sandstone for grindstones is usually associated with quarrying for building purposes as well.

WHETSTONES. Fine grained gray sandstone suitable for whetstones is found at various points in Montgomery, Wythe, Pulaski and Bland Counties. The occurrence along the foothills of the Pilot Mountain in Montgomery County has been already noted. In Bland County, near the Courthouse a whetstone of good quality is found.

Among the silicious slates of Buckingham and Fluvanna Counties in the vicinity of Brems Bluff, beds of stone occur of very fine close grain and possessing in a high degree the necessary qualities of good whetstone.

In the southern part of the State a good whetstone is reported at Lunenburg Courthouse, Lunenburg County.

MICROCLINE: *Potash Feldspar. Green variety—Amazon Stone.*

In composition and general physical properties, essentially identical with Orthoclase, from which it is distinguished by a slight difference in the cleavage angle.

Occurs in considerable quantity in the mica mines near Amelia Courthouse.

MOLYBDENITE: *Molybdenum Disulphide. Mo S₂.*

Specific Gravity, 4.7-4.8. Hardness, 1-2.5. Occurs as hexagonal plates or scales, and in foliated masses resembling graphite. Color, bluish lead-gray. Soft and greasy like graphite, but lighter in color, and gives off sulphur fumes when heated.

Found in small quantity in Rutherford Mica Mine.

MONAZITE: *Phosphate of Cerium, Lanthanum, and other rare earths.*

Specific Gravity, 5-5.5. Occurs as honey yellow or brown

crystals or sand and is the source from which the rare earths used in the manufacture of incandescent mantles are obtained.

Masses weighing as much as eight pounds were obtained in the Amelia Mica Mines, but so far, no deposits of commercial value have been found in Virginia.

MISPICKEL: *See Arsenopyrite.*

MUSCOVITE: *Potash Mica, Common Mica. Aluminium Potassium Silicate. $K_2O Al_3 (SiO_4)_3$.*

Specific Gravity, 2.76-3. Hardness, 2-2.5. Hexagonal or diamond-shaped tabular crystals. Usually found in plates of varying thickness and as scales. Its color is white to colorless, but often tinted various shades of gray, greenish, yellow brown, red or violet. Lustre, vitreous. Transparent and translucent. *See Mica.*

NICKEL: No nickel ores have been found in Virginia, but occasional samples are received from the crystalline belt which show traces of this metal.

NITRE: *Saltpetre. Potassium Nitrate. KNO_3 .*

Specific Gravity, 1.937. Hardness, 2.0. Occurs in minute needle form crystals, masses or encrustations on the surface of rock walls, particularly in limestone caves. Found in Saltpetre Cave, Rockbridge County.

OCHRE: *Red. An earthy variety of Hematite.*

Found in Bedford and Campbell Counties, and other localities on iron ore belts.

OCHRE: *Yellow. An earthy variety of Limonite.*

Large beds of yellow ochre are found in Chesterfield County near Bermuda Hundred; also near Bon Air, Chesterfield County, in Loudoun County near Catoctin Mountain, in Craig County near Roaring Run, and at other points on iron ore belts.

OIL: (Mineral) *Petroleum. See Petroleum.*

OLIGOCLEASE: *Soda-Lime Feldspar. Moonstone.*

Specific Gravity, 2.65-2.69. Hardness, 6-7. Occurs in cleav-

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able masses and plates in gneiss in the mica mines near Hewletts Station, Hanover County.

ONYX: *A variety of quartz.* SiO_2 .

A finer and more regular variety of agate. Found in small quantity with agates in Bland, Giles and Montgomery Counties.

ONYX MARBLE: A variegated banded marble found at Marion, Smyth County and Rockbridge Baths, Rockbridge County.

OPAL: (*Wood*) *Opalized Petrified Wood.* SiO_2 .

Is found near Ashland, Hanover County, where cordwood and parts of trees have been found perfectly petrified.

ORTHOCLASE: *Potash Feldspar. Common Feldspar. Aluminium-Potassium Silicate* $\text{K, Al, Si}_3\text{O}_8$.

Specific Gravity, 2.57. Hardness, 5. Crystals monoclinic. Usually in modified rhombic prisms; frequently twinned; also massive. Cleavage angle 90 degrees. Color, white, gray, yellow, greenish brown, brownish-red. It is one of the constituents of granite, gneiss, etc. Found in large masses and crystals in the mica mines throughout Virginia, that obtained from the Amelia and Hanover Counties, being of very high quality.

PETROLEUM: *Rock Oil. Mineral Oil.*

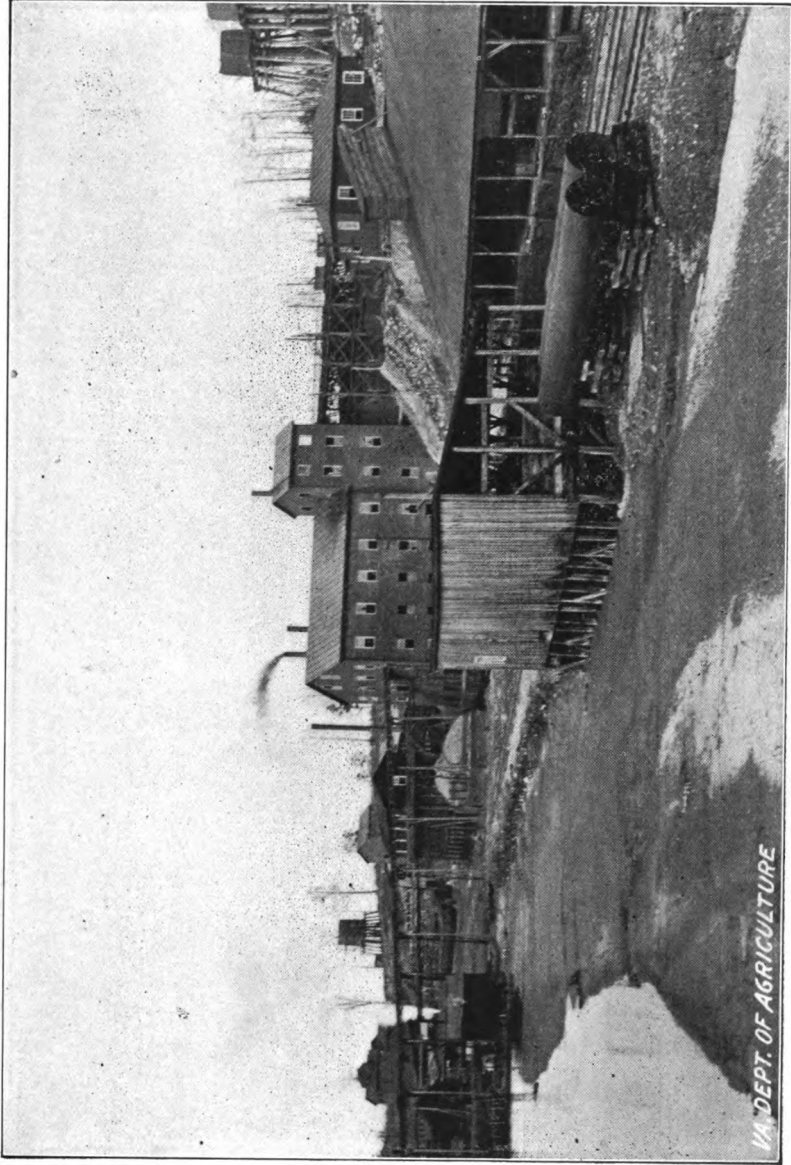
Petroleum has not been found in any quantity in Virginia. At several points particularly about three and one-half miles north of Bristol and near Clifton Forge, a small quantity of oil comes to the surface, but no attempt has been made to determine if it exists in quantity at depth.

PLATINUM: *A native element.* Pt.

Specific Gravity of native metal 14-19; when pure 21-22. Hardness, 4-4.5. Native platinum has not been discovered in Virginia, but traces have been found combined with arsenic in a sample received by us from near Danville.

PSILOMELANE: *Manganese Dioxide with water.* $\text{MnO}_2 \cdot \text{H}_2\text{O}$.

Specific Gravity, 3.7-4.7. Hardness, 5-6. Occurs usually as



PYRITE MINES OF SULPHUR MINES & RAILROAD COMPANY, LOUISA COUNTY.

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nodular and botryoidal masses; also reniform, stalactitic, and in amorphous form. Color, grayish-black to blueblack. Lustre sub-metallic. Streak brownish black. *See Manganese Ore.*

PYRITE: *Iron Pyrites. Iron Disulphide. Fe S₂.*

Specific Gravity, 4.95-5.10. Hardness, 6-6.5. Composition when pure, Iron, 46.6 per cent. Sulphur 53.33 per cent.

Crystallizes in cubes, octahedrons, and other modifications belonging to the Isometric system, and is also found massive and granular. Color, pale brass-yellow. Streak greenish-black or brownish black.

Marcasite known as white pyrites, has the same composition as pyrite, but is lighter in color and its crystals belong to the Orthorhombic system.

Pyrite is one of the most frequently occurring minerals, and is found in the rocks in all parts of the State. It is a constituent of the ore of all the gold mines in the Virginia belt below water level, and it is only when auriferous, or when it occurs comparatively pure and in large quantity, that it is commercially valuable.

The extensive deposits of Louisa County, which are being worked by the Sulphur Mines and Railroad Company and the Arminius Copper Company, are of great interest and importance, contributing as they do about 150,000 tons annually of high grade pyrites—more than half the total output of the United States.

The deposits extend in a northeast and southwest direction in the vicinity of Mineral City for a distance of five miles, and consist of a succession of great lenticular masses of high grade pyrite, lying conformably with the stratification of the enclosing hydromica and talcose slate rocks. In extent these deposits can only be compared to those of Norway, Spain and Portugal, and they possess the advantage over the European deposits, of being quite free from arsenic.

The mines of the Sulphur Mines and Railroad Company extend for about a mile along the lode from the northern end of the outburst.

The deposits have been extensively and carefully developed to

a maximum depth of 700 feet. Three shafts are at present being worked by fifty feet levels, the deepest level being that at 650 feet in the Tinder Flats shaft. The thickness of the veins varies from 12 feet to 55 feet, the average being about 20 feet. The "gossan" cap at these mines was from 50 to 60 feet deep. From this point down to about 150 feet the pyrite is generally partly decomposed and granular in form, below which the solid unaltered pyrite is found.

The mines are fully equipped with the most modern plant for producing a uniform high grade product, and have a capacity of 125,000 ton per annum.

The Arminius mines which extend for about three quarters of a mile along the lode, are separated from the Sulphur Mines property, by a tract which has not yet been developed to any extent. The workings extend to a depth of over 500 feet, and the vein at some points reaches the great width of 60 feet.

The pyrites produced from these deposits is of very high grade, and is particularly characterized by its freedom from arsenic. Numerous analyses have shown a sulphur content of from 48 per cent. to 50 per cent. The average output of the mines, however, contains about 41 per cent. Sulphur.

The following analyses show its composition as compared with the pyrites from the best known foreign deposits:

	SULPHUR.	IRON.	COPPER.	LEAD.	ZINC.	LIME AND MAGNESIA.	ARSENIC.	INSOLUBLE.
	PER CENT	PER CENT	PER CENT	PER CENT	PER CENT	PER CENT	PER CENT	PER CENT
Arminius	49.27	43.62	1.50		.38	1.32		4.23
Sulphur Mines Co..	50.00	43.00						6.02
Wicklow, Ireland..	38.73	36.06	2.57	1.80			.39	19.71
Norway	47.55	41.92	.90		1.29	3.38		6.15
Rio Tinto, Spain....	47.87	40.93	3.33	.62	.10	.19	.26	5.42
San Domingo,								
Portugal	46.00	43.50	3.10	1.60	.32		.30	5.18
Capelton, Canada..	46.60	43.10	3.15	.45	.15	1.30	.15	5.10

(Trans. A. I. M. E. 1884).

On the continuation of this Louisa County belt, running in a northeasterly direction through Spottsylvania, Stafford and Prince

William Counties, minor deposits of pyrites are found at various points.

The only occurrence, however, of importance which has so far been developed is that of Messrs. Dietrick and Bradley in the neighborhood of Dumfries, Prince William County.

This deposit has been developed to a considerable extent, and is shipping pyrites of good quality.

PYROLUSITE: *Black Oxide of Manganese. Manganese dioxide.* MnO_2 .

Contains when pure, Manganese 63.2 per cent. Oxygen, 36.8 per cent. Specific Gravity, 4.82. Hardness, 2-2.5. Color, black or blackish-gray. Structure, columnar, fibrous, acicular, massive granular, and earthy. *See Manganese Ores.*

QUARTZ: *Silica.* SiO_2 .

Specific Gravity, 2.65-2.66. Hardness, 7. Occurs in many crystalline forms and colors, the different shades being due to the presence of small amounts of impurities. Various forms are described under Agate, Amethyst, Chalcedony, Jasper, etc.

RUTILE: *Oxide of Titanium.* TiO_2 .

Specific Gravity, 4.18-4.25. Hardness, 6-6.5. Commonly found as prismatic crystals, the faces of the crystals showing horizontal striations; often in knee-shaped twins. Sometimes found as fine acicular crystals penetrating quartz. Color, reddish brown to red and rarely yellowish, blue or black. Streak, pale brown.

Rutile has recently become important as a source of titanium for the manufacture of titanium-iron alloys. The addition of a small amount of the titanium alloy to cast iron or steel, is said to greatly increase the tensile strength of the metal.

The most important occurrence of this mineral in the world is that at Roseland, Nelson County, where the works of the American Rutile Company have a capacity of 1000 to 2000 pounds of rutile per day.

The mineral is found disseminated through a coarsely crystalline feldspathic quartz rock. The rock is mined by open cuts, and

after crushing and concentrating yields from 5 to 25 per cent. of high grade rutile, quite free from titaniferous iron.

SALT ROCK: *Halite, Sodium Chloride.* NaCl.

Specific Gravity, 2.1-2.6. Hardness, 2.5. Usually crystallizes in cubes, but sometimes in octahedrons. Also occurs extensively in compact granular masses.

Extensive beds of rock salt underlie the great gypsum deposits of the Valley of the Holston River in Washington County.

These deposits are probably co-extensive with the gypsum, which has been mined over a considerable area of the Valley, but the salt industry is confined to the immediate vicinity of Saltville, where large works manufacturing salt, soda ash, soda lye, etc. are operated by the Mathieson Alkali Company.

No mining of the rock salt has been attempted, the entire salt product being obtained from the brine wells. The rock salt of these deposits is very pure, consequently a very high grade of salt is manufactured from the brine.

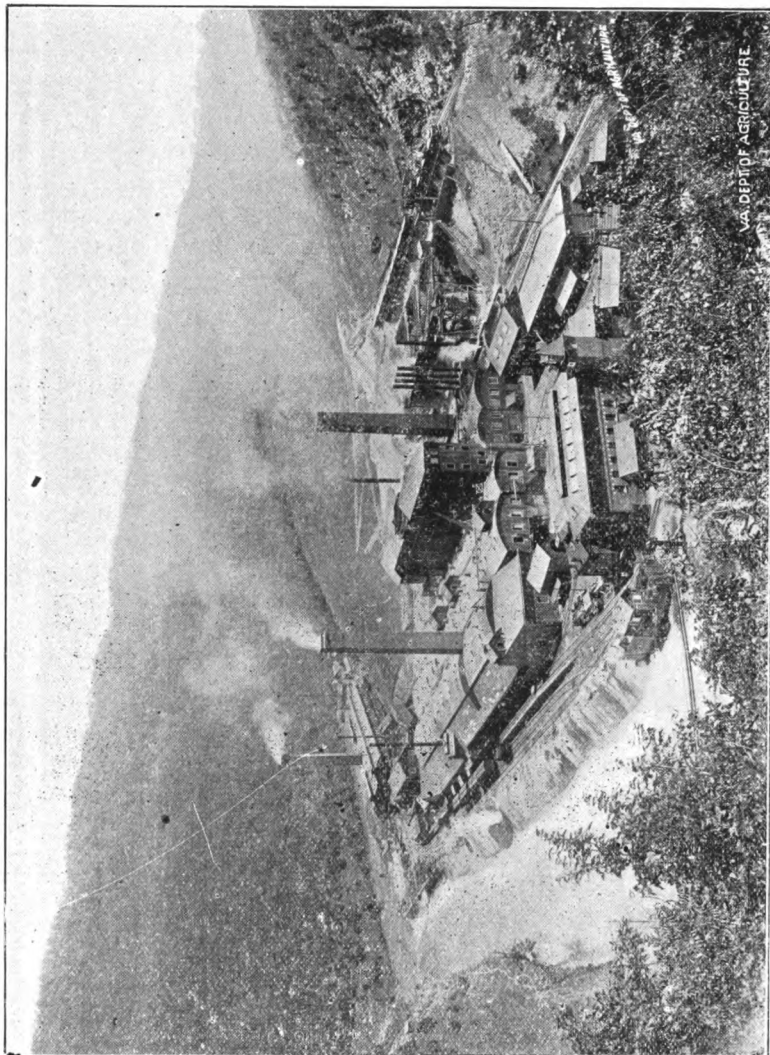
The following analyses show the composition of the rock salt, the solid matter from the brine, and the commercial salt produced:

	ROCK SALT.	BRINE SOLIDS.	COMMERCIAL SALT.
	Per cent.	Per cent.	Per cent.
Sodium Chloride.....	99.08	98.38	99.18
Calcium Chloride.....	trace	....	.27.
Magnesium Chloride.....	....	....	.05
Calcium Sulphate.....	.436	1.22	....
Magnesium Sulphate.....	....	.30	....
Alumina, Silica, Iron and Water	.470	...	.50
	100.00	100.00	100.00
Authority	C. B. Hayden.	G. H. Cook.	G. H. Cook.

SAMARSKITE: *A mineral containing Cerium. Yttrium Lanthanum and other rare earths.*

Specific Gravity, 5.6—5.8. Hardness, 5. 6.

Usually occurs in velvet-black masses or grains, with a shining submetallic lustre. Streak, dark reddish brown. Very rare, but found in small quantity in Rutherford mica mine, Amelia County.



MATHESON ALKALI WORKS, SALTVILLE, VIRGINIA.

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TILDEN FOUNDATIONS.

SAND: *Glass Sand. Moulding Sand.*

Deposits of fine white sand produced by the disintegration of the Potsdam sandstone occur at several points along the southeastern edge of the Shenandoah Valley, and some of these are well suited for glass manufacture. An extensive deposit of this material occurs at Balcony, and at Stapleton Mills, on the land of A. S. Lee, there is a very fine pure white deposit.

MOULDING SAND: For the finer grades of metallic castings, a moulding sand of special physical properties is necessary, and deposits of such a character are comparatively scarce. The sand should be fine, and regular in size of its particles. It must contain a certain amount of clay to give it the necessary plasticity for moulding, but not sufficient to cause shrinkage when exposed to the intense heat of the molten metal.

Some deposits of sand of extra fine quality occur in the vicinity of the city of Richmond. That found on the land of Mr. S. M. Cowardin is highly prized and shipped all over the country.

SELENITE: *See Gypsum.*

SERPENTINE: *Hydrous Magnesium Silicate.*

Specific Gravity, 2.2-2.65. Hardness, 2.5-4. Usually massive and compact, but occasionally found foliated, and at times delicately fibrous. Color, green, of various shades; also gray, greenish yellow, brownish yellow, brown and red. Lustre, slightly resinous.

Serpentine rocks are met with over extensive areas in Albemarle, Nelson and Amherst Counties. In Fairfax County a quarry was opened one and one-half miles southeast of Dranesville, producing a serpentine for building purposes.

SIDERITE: *Spathic Iron. Iron Carbonate.* Fe CO_3 .

Specific Gravity, 3.83-3.88. Hardness, 3.5-4. Color, gray, yellowish, brown, red.

This ore of iron is found in small amount in the coal regions of Southwest Virginia, but not in sufficient quantity to be of any economic importance.

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SLATE: *See Building Stones.*

SPHALERITE: *Blende. Zinc Sulphide. Black Jack. ZnS.*

Specific Gravity, 3.9-4.1. Hardness, 3.5-4. Composition when pure, Zinc 67.18 per cent., Sulphur 32.82 per cent.

Crystallizes in dodecahedrons and modifications, with perfect dodecahedral cleavage. Usually occurs massive; sometimes fibrous or foliated. Color, yellow, brownish-yellow to black; also red, white or green. Streak, white, yellowish to reddish brown. Occurs in the various zinc and lead mines in Wythe and Pulaski Counties; also in considerable quantity in the Faber Mine, Albemarle County and in small quantities in Smyth, Giles, Bland, Tazewell, Russell, Scott and Grayson Counties.

STEATITE OR SOAPSTONE: *See Talc.*

TALC: *Steatite. Soapstone. Hydrous Magnesium Silicate.*
 $3 \text{ MgO}, 4 \text{ SiO}_2, \text{ H}_2\text{O}.$

Specific Gravity, 2.7—2.8. Hardness, 1-1.5. Usually found in foliated masses separable into thin inelastic laminae; also granular and compact. Color, greenish-white, pearly white; also grayish, green, dark green and reddish.

An extensive belt of talcose rocks is found running through Albemarle, Nelson and Amherst Counties, and two extensive quarries are in operation. *See Steatite under "Building Stones."*

TENNANTITE: *Sulpharsenite of Copper and Iron.*

Specific Gravity, 5.1. Hardness, 4-4.5. Color and streak, lead-gray to iron-black. Granular, compact.

Found in London and Virginia and Buckingham Mines, Buckingham County.

TETRAHEDRITE: *Gray Copper Ore. Fehlerz. $4 \text{ Cu}_2\text{S}, \text{ Sb}_2\text{S}_3.$*

Specific Gravity, 4.4-5.1. Hardness, 3-4. Crystallizes in tetrahedrons; also found massive granular, and compact. Color, dark lead or steel-gray. Streak, dark gray. Lustre metallic. Occurs in the "High Hill" Copper Mine in the Virgilina district.

TETRADYMITE: *Bismuth Telluride.*

Specific Gravity, 7.2-7.9. Hardness, 1.5-2. Found as tabular crystals having perfect basal cleavage. Also occurs massive, foliated and granular. Color, pale steel gray. Lustre, splendid metallic. Soils paper. Occurs in many of the gold mines, particularly at the Tellurium Mine in Fluvanna County, and Whitehall Mine in Spottsylvania.

TIN: *See Cassiterite.*

TITANIFEROUS ORES: *See Rutile and Ilmenite.*

TOURMALINE: *A complex silicate of Aluminium and Iron, Magnesium, Sodium, Calcium, or other base, and characterized in all the varieties by the presence of Boron.*

Specific Gravity, 2.89-3.3. Hardness, 7-7.5. Occurs frequently as black or brownish-black prismatic crystals, often slender or acicular. Other colors are, ruby-red, green, brown, yellow, etc. Lustre vitreous. Transparent or translucent. Many fine crystals found in the mica mines of Amelia County.

TRAVERTINE: *Calcareous Tufa. Calcium Carbonate. Ca CO₃.* ✓

Deposited often in thick beds from calcareous waters, either springs or rivers. Found in Jefferson, Frederick, Rockbridge and generally along all the streams in the Valley of Virginia.

TREMOLITE: *A variety of Amphibole. Calcium Magnesium Amphibole. Ca Mg₂ (SiO₄)₃.*

Specific Gravity, 2.9-3.1. Hardness, 5.6. Long bladed crystals; also columnar and fibrous. Color, white and grayish. Sometimes nearly transparent. Found in the greenish talcose rocks at Taylorstown.

TRIPOLITE: *Infusorial Earth.*

A very light, white or grayish white silicious earth, made up of infusorial remains. Largely used as a polishing powder and as an absorbent of nitroglycerine in the manufacture of dynamite.

Extensive deposits of this material are exposed in the hills

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within the City of Richmond; also on the north bank of the Rap-
pahannock River.

TUFA: *See Travertine.*

TURGITE: *Hydrohematite. Hydrrous Ferric Oxide.* $2\text{Fe}_2\text{O}_3$
 H_2O .

Specific Gravity, 4.14-4.6. Resembles limonite, but has a
reddish streak. Occurs in limonites on the western slope of Blue
Ridge.

URALITE: *Pyroxene altered to Amphibole.*

Found in mica mine, Amelia Courthouse.

VERMICULITE: *Hydrrous Magnesium-aluminium-ferrous-sili-
cate.*

Specific Gravity, 2.7. Hardness, 1-2. Occurs as small
foliated scales in steatitic rocks. Color, gray-brown or yellowish
brown. Lustre, pearly. Said to be an alteration product of mica.
Occurs in Nelson County.

VIVIANITE: *Hydrrous Iron Phosphate.* $\text{Fe}_2\text{P}_2\text{O}_8 \cdot 8\text{H}_2\text{O}$.

Specific Gravity, 2.58-2.68. Hardness, 1.5-2. Crystals,
slender prismatic; acicular; also radiated, reniform and earthy.
Color, deep blue, greenish-blue. Found in bog iron ore in Staf-
ford County and in clay excavated from James River at Richmond.

WAD: *Bog Manganese. Impure Manganese Dioxide.*

Specific Gravity, 3-4. Hardness, 3-4. Occurs massive, reni-
form or earthy. Color and streak, black or brownish black.
Localities: Waynesboro, Craigs Creek and near New Castle.

WILLIAMSITE: *A coarse foliated variety of Serpentine.*

Locality: Fairfax County.

WOLFRAMITE: *Wolfram. Tungstate of Iron and Manganese.*

Specific Gravity, 7.2-7.5. Hardness 5-5.5. Crystals, thick
tabular, or prismatic; massive; compact. Color, dark grayish or

brownish black. Streak dark reddish brown. Submetallic to metallic lustre.

Occurs in Grayson County.

ZINC BLENDE: *See Sphalerite.*

ZINC ORES: Large deposits of zinc ores including calamine, sphalerite (blende) and smithsonite, occur associated with galena and other lead ores, in Wythe and Pulaski Counties, and are being extensively worked by the Bertha Mining Company, whose zinc works at Martins, Pulaski County, produce a spelter of exceptional purity.

These Wythe and Pulaski deposits have already been described under Galena.

ZIRCON: *Silicate of Zirconium, Zr SiO₄.*

Specific Gravity, 4.68-47. Hardness, 7.5. Occurs usually as square prisms, colorless, grayish, pale yellow to reddish brown in color.

Has been found in small quantity in Rutherford Mica Mine.

**Mineral Waters and Spring
Resorts of Virginia.**

MINERAL WATERS AND SPRING RESORTS.

The numerous and valuable Mineral Springs of Virginia have long been famous, and for generations many of the resorts have been annually frequented by visitors from all parts of the country, attracted by their beauty and charm, and the curative properties of the waters.

The chief spring section of the State embraces the mountains, high plateaus and valleys of the Blue Ridge and Alleghanies. Most of the best known spring resorts are located in this favored region amid surroundings of picturesque scenic beauty which could hardly be excelled.

East of the Blue Ridge many fine springs occur in the Piedmont and more level country stretching toward the coast, and some of the light alkaline-lithic waters of this section have an extensive sale all over the eastern and southern States.

All classes of mineral water occur. The thermal springs are confined to the mountain region, but fine chalybeate, sulphuretted, alum, alkaline-lithic and saline waters are numerous all over the State.

In the following pages descriptions and analyses of all the important springs will be found. The information contained therein has been obtained partly from published works, and partly from personal examination, and the latest analyses available have been used throughout.

ALLEGHANY SPRINGS.

Location: Montgomery County. Postoffice, Alleghany Springs. Distant three and one-half miles from Shawsville Station, on Norfolk & Western Railway, from which point carriages run to the springs.

This well known watering place is situated on the eastern slope of the Alleghany Mountains, in the midst of some of the finest scenery to be found in the State. The hotel and cottage accommodations are of the best and are equipped with all modern conveniences. There are a number of springs on the prop-

erty, but only one is used at present. It yields about 30 gallons per hour of a limpid, pleasant tasting water, which has a temperature of 56 degrees Far.

The following analysis by Dr. F. A. Genth, shows its composition:

Class: *Sulphated—(magnesia)—saline.*

One United States gallon of 231 cubic inches contains:

Calcium carbonate	3.61	grains.
Magnesium carbonate	0.36	"
Lithium carbonate	trace	"
Strontium carbonate	0.06	"
Barium carbonate	0.02	"
Magnesium carbonate	0.06	"
Iron carbonate	0.16	"
Cobalt carbonate	trace	"
Zinc carbonate	trace	"
Copper carbonate	trace	"
Lead carbonate	trace	"
Sodium sulphate	1.72	"
Calcium sulphate	115.29	"
Magnesium sulphate	50.88	"
Potassium sulphate	3.70	"
Magnesium nitrate	3.22	"
Aluminium nitrate	0.56	"
Aluminium phosphate	0.03	"
Aluminium silicate	0.21	"
Sodium chloride	0.28	"
Calcium fluoride	0.02	"
Antimonium oxide	trace	"
Silica	0.88	"
Crenic acid	trace	"
Aprorenic acid	trace	"
Organic matter	2.06	"

Gases: 183.06 "

Carbonic acid

Sulphureted hydrogen

This water has a wide reputation and is bottled and shipped to all parts of the country. It is a valuable anti-dyspeptic, and has also a very beneficial effect in cases of liver and kidney trouble. When taken in large doses it acts as an active diuretic and cathartic, while in small doses, its action is tonic and reconstructive, and it has been found to give excellent results in the treatment of anaemia, chlorosis and other diseases consequent upon a debilitated condition.

AUGUSTA OR STRIBLING SPRINGS.

Location: Augusta County. Postoffice, Stribling Springs. Access by Chesapeake & Ohio Railway to Staunton, and then thirteen miles northwest by stage.

This is an old and celebrated resort with a number of Alum and Chalybeate springs, and from its sheltered location the climate is milder in the early spring and late fall than at most other Virginia resorts.

The following analyses by Dr. T. K. Tuttle, show the composition of these waters:

ALUM SPRING.

One United States gallon of 231 cubic inches contains:

Sulphate of potassa	1.008	grains.
Sulphate of soda	1.792	"
Sulphate of magnesia	6.576	"
Sulphate of alumina	38.408	"
Sulphate of iron	12.920	"
Sulphate of lime	19.112	"
Sulphuric acid (free)	6.536	"
Silicic acid	2.112	"
Organic matter	—	—
Total	88.464	"

CHALYBEATE SPRING.

One United States gallon of 231 cubic inches contains:

Carbonate of potassa .....	.734	grains.
Carbonate of soda	7.240	"
Carbonate of magnesia	2.008	"
Carbonate of iron .....	.128	"
Carbonate of lime	9.632	"
Chloride of sodium .....	.640	"
Sulphate of lime	1.248	"
Silicic acid .....	.640	"
	21.280	"

BATH ALUM SPRINGS.

Location: Bath County. Postoffice, Bath Alum. This well known spring resort is situated in the midst of picturesque mountain scenery. It lies at the base of the Warm Springs Mountain, midway between Millboro, on the main line, and Hot

Springs, on the Hot Springs branch of the Chesapeake & Ohio Railway, and is reached from the former station by stage, the distance being ten miles. The accommodations consist of a good brick hotel and cottages, with all modern conveniences.

There are five springs, and the following analyses taken from the United States Geological Reports give the composition of three of them:

Class: *Acid-chalybeate. Aluminous.*

One United States gallon of 231 cubic inches contains:

	Spring 1.	Spring 2.	Spring 3.
Sodium sulphate...— grs.	1.13 grs.	— grs.	— grs.
Calcium sulphate .. 3.80 "	1.71 "	— "	— "
Lithium sulphate ...— "	trace	— "	— "
Magnesium sulphate 2.82 "	0.46 "	— "	— "
Potassium sulphate — "	0.34 "	0.26 "	— "
Aluminium sulphate — "	29.99 "	— "	— "
Ammonium sulphate — "	trace	— "	— "
Manganese sulphate — "	0.03 "	— "	— "
Iron persulphate ...— "	26.78 "	— "	— "
Aluminium phosphate — "	— "	3.15 "	— "
Ammonium crenate 1.85 "	— "	1.77 "	— "
Sodium silicate 2.02 "	— "	— "	— "
Sodium chloride 0.17 "	0.11 "	— "	— "
Magnesia	— "	1.28 "	— "
Iron oxide	14.52 "	21.77 "	— "
Alumina	10.29 "	12.29 "	— "
Silica	1.95 "	— "	— "
Sulphuric acid	5.81 "	2.88 "	7.88 "
Carbonic acid	4.14 "	— "	3.85 "
Aprocrenic acid ...— "	— "	— "	2.54 "
Oxygen with sodium 0.02 "	— "	— "	— "
	45.14 "	65.38 "	54.79 "

Carbonic acid gas (Spring No. 1.) .. 4.65 cubic inches.

From the unusually large amount of Sulphates of Iron and Alumina present in these waters, they have strong tonic and astringent properties and are very valuable in the treatment of scrofulous diseases. They have also marked beneficial effect in cases of chronic diarrhoea, and all diseases resulting from general debility, or an impoverished condition of the blood.

BEAUFONT LITHIA SPRING.

Location: Chesterfield County. Postoffice, Richmond. The spring, which is located about eight miles from Richmond, is not used as a resort, but the water is bottled and has an extensive sale. It is highly esteemed as a table water, and has proven useful in the treatment of gout and rheumatism, and from its sedative effect, in cases of nervous irritation.

The analysis made in this laboratory shows the following composition:

Class: *Light Lithic-carbonated.*

One United States gallon of 231 cubic inches contains:

Magnesium bi-carbonate .....	.38956	grains.
Calcium bi-carbonate .....	.35282	"
Sodium bi-carbonate .....	.34923	"
Iron (ferrous) bi-carbonate .....	.04741	"
Manganous bi-carbonate	trace	"
Potassium sulphate .....	.13646	"
Potassium chloride .....	.12947	"
Sodium chloride .....	.35749	"
Sodium iodide .....	.00412	"
Sodium bromide	trace	"
Sodium arsenate	trace	"
Sodium phosphate .....	.00332	"
Lithium chloride .....	.02799	"
Alumina .....	.02099	"
Silicic acid .....	.96691	"
	<hr/>	
	2.78577	"
Carbon dioxide free (gas)	8.5	cubic inches.

BEAVER LITHIA SPRING.

Location: Mecklenburg County. Postoffice, Buffalo Junction. Access by Atlantic & Danville Railway to Buffalo Junction, then one mile to the spring by private conveyance.

This spring, which has been known for its curative properties since the time of the Indians, is situated at an altitude of 500 feet above sea-level, about four miles from the well known Buffalo Lithia Springs. Analysis of the water made in this laboratory in 1898 gave the following results:

Class: *Sulphated-saline Lithic.*

One United States gallon of 231 cubic inches contains:

Magnesium carbonate	1.30574	grains.
Calcium carbonate	5.16756	"
Strontium carbonate .....	.03033	"
Barium carbonate .....	.01225	"
Iron (ferrous) carbonate .....	.05074	"
Manganous carbonate .....	.00466	"
Copper, zinc and lead carbonate ...	traces	"
Magnesium sulphate .....	.14113	"
Calcium sulphate	6.79113	"
Potassium sulphate .....	.55285	"
Sodium sulphate	1.16928	"
Sodium hyposulphite .....	.06415	"
Sodium chloride .....	.35691	"
Sodium iodide .....	.00004	"
Sodium bromide .....	.00058	"
Sodium arsenate .....	.00082	"
Sodium phosphate .....	.01458	"
Lithium chloride .....	.07849	"
Calcium fluoride .....	.03499	"
Alumina .....	.11080	"
Silica	2.56016	"

18.44719 "

Carbon dioxide combined

2.95556 "

21.40275 "

Carbon dioxide free

3.99

cubic inches.

This water is distinguished by the variety of its mineral ingredients, some of which, though present only in minute quantity, undoubtedly impart to it marked therapeutical properties.

It has been extensively used with much benefit in cases of dyspepsia, and kidney diseases, and also acts as a nerve sedative and tonic.

BEDFORD ALUM SPRINGS.

Location: Campbell County. Postoffice, Bedford Springs. Access by Norfolk & Western Railway to Forest Station, or by Southern Railway to Lawyer's Depot, and from either of these points, by carriage to the springs—a distance of four miles.

These springs are at an altitude of about 1,300 feet above sea-level, and are located in a most beautiful and interesting part

of the country. They are within ten miles of the city of Lynchburg and not far from the Natural Bridge. There is an excellent, fully equipped hotel at the springs.

The following analysis by Prof. M. B. Hardin, shows the composition of the water:

Class: *Acid-chalybeate. Aluminous.*

One United States gallon of 231 cubic inches contains:

Copper sulphate	0.06	grains.
Iron proto-sulphate (ferrous)	0.59	"
Iron persulphate (ferric)	19.26	"
Aluminium sulphate	24.18	"
Manganese sulphate	0.19	"
Zinc sulphate	0.07	"
Nickel sulphate	0.04	"
Cobalt sulphate	0.07	"
Calcium sulphate	4.99	"
Magnesium sulphate	12.58	"
Potassium sulphate	0.71	"
Sodium sulphate	0.87	"
Lithium sulphate	0.24	"
Sulphuric acid	4.01	"
Silica	1.69	"
Calcium phosphate	0.30	"
Magnesium nitrate	0.26	"
Ammonium nitrate	0.24	"
Sodium chloride	0.20	"
Calcium fluoride	trace	"
Organic matter	0.29	"
Total	70.84	"
Gases:		
Carbonic acid	6.98	cubic inches.
Oxygen	1.32	" "
Nitrogen	3.33	" "
	11.63	" "

Temperature of water 48 degrees to 56 degrees Far.

As will be seen from the above analysis, the water is tonic astringent, diuretic and alterative in character, and in practice it has been found efficacious in the treatment of many diseases. When taken in large doses it acts as an aperient, while in small doses it is very beneficial in cases of intestinal disorders. The water and the evaporated residue known as "Bedford Mass" are shipped on order.

. BERRY HILL LITHIA WATER.

Location: Culpeper County. Postoffice, Culpeper Court-house. Access by Southern Railway to Culpeper, thence by private conveyance to the spring.

This valuable spring has long had a great reputation for curative properties, in the various counties adjacent to Culpeper, and extensive improvements in the resort are now in progress.

Analysis made by Dr. Henry Froehling, in 1899, shows the water to have the following composition:

Class: *Lithic Sulphated-saline Aluminous.*

One United States gallon of 231 cubic inches contains:

Magnesium carbonate	2.62723	grains.
Calcium carbonate	6.91651	"
Strontium carbonate .....	.52544	"
Iron (ferrous) carbonate .....	.21753	"
Manganous carbonate .....	.00641	"
Magnesium sulphate	13.90418	"
Calcium sulphate	93.69369	"
Aluminum sulphate	11.06467	"
Potassium sulphate .....	.95699	"
Sodium sulphate	30.44199	"
Sodium hypophosphite	1.08472	"
Sodium chloride	2.29773	"
Sodium iodide .....	.00204	"
Sodium phosphate .....	.05365	"
Lithium chloride .....	.07342	"
Calcium fluoride .....	.03499	"
Silica .....	.99141	"
	<hr/>	
	164.89260	"
Carbon dioxide combined	4.51556	"
	<hr/>	
	169.40816	"

Carbon dioxide free

4.26 cubic inches.

This water possesses valuable anti-acid, diuretic and laxative properties, and in practice, has given excellent results in the treatment in a wide range of diseases. It is recommended as a permanent cure for dyspepsia and other stomach troubles, and in long standing cases of gout and rheumatism, its persistent use has been very efficacious. In the treatment of constipation, torpidity of the liver, and as a general alterative its use has been

attended by marked good results, and it is highly recommended in chronic disorders of the female generative organs.

BLUE RIDGE SPRINGS.

Location: Botetourt County. Postoffice, Blue Ridge Springs. Access to the springs is via. the Norfolk & Western Railway. Station, Blue Ridge Springs.

This resort is beautifully located in a picturesque valley in the Blue Ridge Mountains at an altitude of 1,300 feet above sea-level. The spring yields about 130 gallons of water per hour, having a constant temperature of 52 degrees Far.

An analysis made in this laboratory gave the following results:

Class: *Sulphated-saline. Carbonated.*

One United States gallon of 231 cubic inches contains:

Magnesium sulphate	47.01306	grains.
Calcium sulphate	100.13201	"
Sodium sulphate .....	.36740	"
Potassium sulphate .....	.65724	"
Magnesium carbonate	1.21885	"
Calcium carbonate	3.96562	"
Strontium carbonate .....	.29509	"
Barium carbonate .....	.02566	"
Manganese carbonate .....	.01749	"
Nickel and cobalt carbonate	trace	"
Iron (ferrous) carbonate .....	.10847	"
Lead carbonate	trace	"
Copper carbonate	trace	"
Sodium chloride	1.25967	"
Lithium chloride .....	.03732	"
Sodium arsenate .....	.00210	"
Sodium iodide .....	.00026	"
Sodium bromide	trace	"
Calcium fluoride .....	.00146	"
Magnesium nitrate .....	.35574	"
Ammonium nitrate .....	.02814	"
Aluminium phosphate .....	.01575	"
Aluminium silicate .....	.15279	"
Silicic acid	1.35298	"

157.00710 "

Carbon dioxide combined

2.57648 "

Gases:

159.58358 "

Carbon dioxide

38.2 cubic inches.

Hydrogen sulphide

3.00 " "

The properties of the water are anti-acid and tonic. It is very efficacious in cases of acid dyspepsia, and acts as a corrective in both diarrhoea and constipation.

The water is bottled and has an extensive sale.

BRUNSWICK INN LITHIA SPRINGS.

Location: Augusta County. Postoffice, Waynesboro. Access by Chesapeake & Ohio or Norfolk & Western Railways to Waynesboro.

This resort is situated at the western base of the Blue Ridge, amidst the beautiful scenery of the Shenandoah Valley. The inn is modern in construction and well supplied with all conveniences for comfort and recreation.

The springs are six in number, and the composition of the water is shown in the following analysis made in this laboratory:

Class: *Alkaline-carbonated...Lithic.*

One United States gallon of 231 cubic inches contains:

Magnesium carbonate	1.342	grains.
Calcium carbonate	1.519	"
Strontium carbonate .....	.002	"
Barium carbonate .....	.002	"
Iron (ferrous) carbonate .....	.003	"
Manganous carbonate .....	.001	"
Calcium chloride .....	.141	"
Sodium chloride .....	.361	"
Lithium chloride .....	.023	"
Calcium sulphate .....	.107	"
Potassium sulphate .....	.176	"
Sodium iodide .....	.008	"
Sodium bromide	trace	"
Sodium arsenate .....	.001	"
Sodium phosphate	trace	"
Calcium fluoride	trace	"
Silica .....	.544	"
Alumina .....	.025	"
Total	4.255	"
Carbonic acid combined with mono-carbonates to form bi-carbonates	1.368	"
	5.623	"
Free carbonic acid	10.28	cubic inches.

BUCKINGHAM WHITE SULPHUR SPRINGS.

Location: Buckingham County. Postoffice, Buckingham Courthouse. Once much frequented, but at present little used. No analysis is obtainable.

BUFFALO LITHIA SPRINGS.

Location: Mecklenburg County. Postoffice, Buffalo Lithia Springs. This well known resort is reached over the Atlantic and Danville division of the Southern Railway or by private conveyance from Clarksville, on Southern Railway—a distance of 8 miles.

The hotel buildings are on the cottage plan and accommodate 250 guests, and the equipment, including bath-house, is of the most modern kind. The hotel is open from June 15th to October 1st.

The "Buffalo Lithia" is one of the best known mineral waters in the United States, and has a very large sale in this country and abroad. There are three springs known respectively as Nos. 1, 2 and 3. The waters from springs 1 and 2 are richest in mineral matters and are those used for bottling and sale.

The following analysis of spring No. 2, by Prof. Wm. P. Joury, shows its composition:

Class: *Lithia, Aluminous. Calcic.*

One United States gallon of 231 cubic inches contains:

Magnesium sulphate	0.88	grains.
Aluminium sulphate	9.07	"
Calcium sulphate	33.06	"
Potassium carbonate	29.30	"
Calcium bi-carbonate	14.96	"
Lithium bi-carbonate	2.25	"
Iron bi-carbonate	0.30	"
Baryta bi-carbonate	1.75	"
Sodium chloride	4.92	"
Silica chloride	1.87	"
Phosphoric acid	traces	
Iodine	traces	
Organic matter	small amount	
	98.36	"
Sulphureted hydrogen	8.30	cubic inches.
Carbonic acid	59.20	" "

This water is of great medicinal value, and is regarded almost as a specific in the treatment of uric acid diathesis, gout and rheumatism. It is also used with great benefit in cases of renal calculus, stone in the bladder, and in nervous and intestinal disorders.

The water of No. 3 spring is a strong chalybeate with valuable tonic properties, but is only used at the springs.

BURNER'S SPRINGS.

Location: Shenandoah County. Postoffice, Woodstock. Access by Norfolk & Western Railway, to Overalls Station, thence six miles to the springs by private conveyance; or from Waterlick on the Southern Railway, or Woodstock on the Baltimore & Ohio Railway, both distant twelve miles from the springs.

The springs, which are seven in number and sometimes called the Seven Fountains, are beautifully located at an altitude of 1,500 feet. No analysis of the water is available, but it is said to be very beneficial in the treatment of gout, rheumatism, intestinal troubles and nervous disorders.

THE CAMPFIELD LITHIA SPRINGS.

Location: Chesterfield County. Postoffice, Manchester. The springs are located at Temple's, and are not used as a resort. The water is for sale as a table water, and is also used medicinally in the treatment of gout and indigestion.

The analysis by Prof. N. B. Tucker, shows the following composition:

One United States gallon of 231 cubic inches contains:

Magnesium bi-carbonate	0.32959	grains.
Calcium bi-carbonate	0.20300	"
Iron (ferrous) bi-carbonate	0.05649	"
Manganese bi-carbonate	trace	
Potassium sulphate	0.25214	"
Lithium chloride	0.01834	"
Sodium chloride	0.47250	"

Sodium iodide	0.00014	grains.
Sodium bromide	trace	
Sodium arsenate	trace	
Sodium phosphate	0.00242	"
Silicic acid	0.30917	"
Alumina	0.01283	"
Barium sulphate	0.00027	"
	<hr/>	
Total mineral matter	1.65749	"
Free carbon dioxide	6.32	cubic inches.

CHASE CITY MINERAL SPRINGS.

Location: Mecklenburg County. Postoffice, Chase City. Access by Southern Railway to Chase City. Accommodation, a fine hotel and sanitarium with all modern improvements.

There are two springs of widely different character, one of which is a Chloride of Calcium water of much value.

Its composition is shown in the following analysis by Dr. W. H. Taylor:

One United States gallon of 231 cubic inches contains:

Calcium bi-carbonate	7.0900	grains.
Ferrous bi-carbonate	1.8900	"
Calcium chloride	46.0900	"
Magnesium chloride	8.1500	"
Sodium chloride	15.3500	"
Potassium chloride .....	.4800	"
Potassium sulphate.....	.1500	"
Silicon dioxide	2.4800	"
	<hr/>	
	81.5900	"

This water has proven almost a specific in skin diseases, catarrhal affections, constipation, and all diseases where an alterative is required.

The water of the other spring, known as "Chase City Lithia," is a fine diuretic, and has given excellent results in the treatment of Bright's disease, renal calculus, gravel, uric acid diathesis, and nervous and gastro-intestinal disorders.

Its composition is shown in the following by Ledoux & Company:

110 MINERAL WATERS AND SPRING RESORTS.

One United States gallon of 231 cubic inches contains:

Sodium chloride	2.3327	grains.
Sodium bromide	traces	
Sodium iodide	traces	
Manesium bi-carbonate	2.1286	"
Calcium bi-carbonate	7.0390	"
Ferrous bi-carbonate	0.0816	"
Magnesium chloride	2.7642	"
Potassium sulphate	0.1458	"
Sodium sulphate	0.1108	"
Alumnia	9.0874	"
Silicon dioxide	1.6795	"
Lithium chloride	trace	"
Organic and volatile matter	2.2724	"
<hr/>		
Total mineral matter	27.6420	"

Both these waters are bottled and shipped on order to all parts of the country.

CLAYFORD CHALYBEATE SPRINGS.

Location: Tazewell County. Postoffice, Burke's Garden. Access from Tazewell, on Norfolk & Western Railway, twelve miles distant, by private conveyance. Good accommodation can be obtained at the Groseclose Inn, two miles from the springs, in the beautiful valley known as Burke's Garden.

The springs are in the midst of beautiful mountain scenery, the main spring being located on the mountain side at an altitude of 3,100 feet. The water has a temperature of 50 degrees Far., and is said to be a fine chalybeate, highly recommended in all disorders resulting from debilitated condition.

CLIFTON SPRINGS.

Location: Alleghany County. Postoffice, Clifton Forge. Access via. Chesapeake & Ohio Railway to Clifton Forge.

The springs are four in number. The waters are alkaline and chalybeate in their nature, and have gained for themselves considerable reputation in the treatment of anaemia, chlorosis and general debility. The temperature of the water flowing from the springs is from 58 degrees to 62 degrees Far.

The following analyses of the waters of two of the springs,

made by Prof. J. L. Campbell, show their composition. (Bulletin 32 United States Geological Survey):

One United States gallon of 231 cubic inches contains:

	Spring No. 1.	Spring No. 2.
Soda	0.584 grains.	4.182 grains.
Magnesia	0.325 "	3.202 "
Potash	0.153 "	0.648 "
Lime	1.226 "	21.830 "
Lithia	trace	trace
Iron oxide	1.109 "	trace
Manganese protoxide	trace	— " "
Alumina	0.076 "	— " "
Silica	0.728 "	1.177 "
Chlorine	0.052 "	0.765 "
Phosphoric acid	— " "	trace
Sulphuric acid	0.721 "	2.236 "
Carbonic acid	2.069 "	22.373 "
Organic acid (with ammonia)	0.422 "	— " "
Organic matter	— " "	trace
	<hr/> 7.565 "	<hr/> 56.415 "

COLEMAN'S MINERAL SPRINGS.

Location: Cumberland County. Postoffice, Lucyville.
Access via. Farmville, on Norfolk & Western Railway.

Eighty-seven springs presenting great variety in composition are found at this point. Extensive developments of the resort have been carried out, and excellent hotel and cottage accommodations are available.

The following analyses by Dr. W. H. Taylor, show the composition of two of the most important springs:

Class: *Mild Alkaline-saline.*

SPRING NO. 7.

One United States gallon of 231 cubic inches contains:

Calcium bi-carbonate	7.93 grains.
Magnesium bi-carbonate	5.52 "
Iron bi-carbonate	trace
Lithium bi-carbonate	trace
Potassium sulphate	0.22 "
Sodium chloride	1.87 "
Potassium chloride	0.04 "
Magnesium chloride	0.45 "
Silica	3.38 "
Total	<hr/> 19.41 "

Class: *Mild Alkaline-chalybeate.*

SPRING NO. 19.

One United States gallon of 231 cubic inches contains:

Iron bi-carbonate	1.69	grains.
Calcium bi-carbonate	1.52	"
Magnesium bi-carbonate	1.15	"
Sodium bi-carbonate	1.24	"
Lithium bi-carbonate	trace	
Potassium sulphate	0.13	"
Sodium chloride	0.15	"
Potassium chloride	0.05	"
Silica	2.45	"
Total	8.38	"

The water is recommended in cases of diseases of the stomach and intestines and in some diseases of the kidney; also as a tonic in general debility.

COPPAHAUNK LITHIA-ARSENIC SPRINGS.

Location: Sussex County. Postoffice, Waverly. Access by Norfolk & Western Railway to Waverly, thence one and one-half miles to the springs.

There are two springs on the property, about 40 feet apart, with a flow of about 200 gallons per hour. These springs were known and used in colonial days by the inhabitants of the lower counties.

The water is known for its curative properties in the incipient stages of Bright's disease, and has a very beneficial effect in uric acid diathesis, nephritic colic, liver and stomach troubles. It is bottled and shipped on order.

An analysis of the water from one of the springs made in this laboratory, gave the following results:

One United States gallon of 231 cubic inches contains:

Calcium carbonate	13.62308	grains.
Magnesium carbonate .....	.17816	"
Strontium carbonate .....	.01032	"
Barium carbonate .....	.01248	"
Iron (ferrous) carbonate .....	.08699	"
Manganese and zinc carbonate,	faint traces	

Potassium sulphate .....	.24394	grains.
Magnesium chloride .....	.14801	"
Potassium chloride .....	.02951	"
Lithium chloride .....	.06665	"
Sodium chloride .....	.80012	"
Sodium iodide and bromide	traces	"
Sodium arsenate .....	.00303	"
Aluminium phosphate .....	.00851	"
Aluminium silicate	1.92449	"
	17.19951	"
Carbon dioxide combined with mono-carbonates to form bi- carbonates	6.16771	"
Total	23.36722	"
Gases:		
Carbon dioxide	7.128	cubic inches.
Nitrogen	1.460	" "
Oxygen .....	.940	" "

COVE LITHIA SPRING.

Location: Wythe County. Postoffice, Wytheville.

This water is well known and has an extensive sale but no accommodations for visitors exist at the spring. It is situated a few miles northeast of Wytheville, in which beautiful town good hotel or boarding house accommodation can be obtained.

An analysis of the water made in this laboratory gave the following results:

Class: *Alkaline-calcic. Lithic.*

One United States gallon of 231 cubic inches contains:

Calcium carbonate	1.527	grains.
Magnesium carbonate	2.435	"
Sodium carbonate	1.049	"
Lithium carbonate .....	.017	"
Iron carbonate .....	.865	"
Manganese carbonate .....	.047	"
Strontium carbonate .....	.001	"
Barium carbonate .....	.012	"
Lead and copper carbonates	trace	"
Sodium chloride .....	.211	"
Sodium iodide .....	.004	"
Sodium hyposulphite .....	.011	"
Sodium sulphate .....	.085	"
Sodium borate	trace	"

Potassium sulphate .....	.177	grains.
Aluminium phosphate .....	.037	"
Ammonium nitrate .....	.017	"
Alumina .....	.056	"
Silica	1.309	"
	<hr/>	
	7.86	"
Carbonic acid combined with mono- carbonates to form bi-carbonates	2.737	"
	<hr/>	
Total ingredients	10.697	"
Free carbonic acid gas	13.4	cubic inches.
Sulphureted hydrogen .....	.38	"

The water is a valuable one and is used with excellent results in various diseases. Its action is anti-acid, tonic, diuretic, and alterative. It has been found particularly efficacious in kidney and bladder troubles, and its use in rheumatism, dyspepsia and female disorders it attended with most beneficial results.

COYNERS SULPHUR SPRINGS.

Location: Botetourt County. Postoffice, Bonsack, Roanoke County. Access via. Norfolk & Western Railway to Coyners Springs.

Five varieties of waters are said to be found at these springs, and they have long had a high reputation for curative properties, though no analysis are recorded.

Preparations are now being made for reopening the resort.

CRAIG HEALING SPRINGS.

Location: Craig County. Postoffice, Eakin. Access by Craig Valley division of Chesapeake & Ohio Railway to Newcastle; thence by carriage to the springs, about twelve miles distant.

These springs are beautifully situated at Eakin near the base of Potts Mountain in the midst of picturesque scenery.

The accommodations consist of a comfortable hotel, fully equipped with modern conveniences.

The water, according to a partial analysis by Dr. Clifford

Richardson, contains $7\frac{1}{4}$ grains per gallon of solids, consisting of carbonate of lime, carbonic acid, iron, magnesia, lithia and sulphuric acid. It is said to be strongly diuretic and tonic in its effect, and is strongly recommended for stomach troubles, rheumatism, and skin diseases.

CROCKETTS ARSENIC LITHIA SPRINGS.

Location: Montgomery County. Postoffice, Shawsville. Access by Norfolk & Western Railway to Shawsville, thence by private conveyance to the springs, seven miles distant.

This attractive resort is located at an altitude of 2,000 feet in the midst of the beautiful and picturesque mountain scenery of the Alleghanias. A fine modern hotel, fully equipped with all modern conveniences, is on the property, and many facilities for entertainment have been provided, including lawn tennis courts, croquet grounds and bowling alley. Good hunting and fishing are also found in the neighborhood.

The spring may almost be classed as a thermal one, the minimum temperature of the water being 70 degrees Far., and its composition is shown in the following analysis made in this laboratory:

Class: *Sulphated-saline. Arsenical and Lithic.*

One United States gallon of 231 cubic inches contains:

Magnesium carbonate	1.18	grains.
Calcium carbonate	5.90	"
Strontium carbonate	0.09	"
Barium carbonate	trace	"
Lithium carbonate	0.07	"
Copper carbonate	trace	"
Lead carbonate	trace	"
Zinc carbonate	trace	"
Manganese carbonate	trace	"
Magnesium sulphate	3.04	"
Calcium sulphate	2.25	"
Potassium sulphate	1.25	"
Iron sulphate	0.04	"
Sodium sulphate	1.86	"
Sodium chloride	1.23	"
Sodium bromide	0.01	"
Sodium iodide	trace	"

Sodium arsenate	0.02	grains.
Aluminium phosphate	trace	"
Aluminium silicate	0.12	"
Ammonium nitrate	trace	"
Silicic acid	1.29	"
	<hr/>	
	18.35	"
Carbonic anhydride combined with mono-carbonates to form bi- carbonates	3.23	"
	<hr/>	
	21.58	"

This water gives excellent results as an alterative, blood and nerve tonic, and eliminator, and is used with particular benefit in various chronic skin diseases. When taken in quantity it produces very decidedly the effects of arsenic, and in the treatment of the various diseases, in which this element is used, a free use of the water it attended with much benefit.

The water is used both externally and internally, and the bathing facilities, which are very good, are under the supervision of a resident physician.

The water is bottled and shipped on order.

DAGGERS SPRINGS.

Location: Botetourt County. Postoffice, Dagers. Access by James River division of Chesapeake & Ohio Railway to Gala Water Station, and by private conveyance to the springs about three miles distant. Dagers Springs were opened about 1842 and well patronized even when they could only be reached by a long stage ride.

The springs are very pleasantly located at the base of the Blue Ridge, and are well described in the Dagers' Springs circular as follows: "Cool breezes, refreshing days, restful nights, no mosquitoes, shady lawn, trout fishing in mountain streams, bass fishing in James River, good hunting in its season, lawn tennis, croquet, etc. Fine mineral waters, sulphur, iron and lithia, a cool lithia pool bath within easy reach, a hot lithia tub bath at the hotel. A resident physician, daily mails, comfortable rooms, an

old Virginia cook, an old Virginia reel, an old Virginia welcome, and a very moderate bill.”

The waters are sulphur, chalybeate and lithia, but no complete analyses have been made.

The sulphur water is said to give good results in liver, stomach and kidney troubles, rheumatism and skin diseases, while the water of the chalybeate spring is used with much benefit in anaemia, chlorosis and general debility.

The lithia water is valuable for uric acid diathesis, dyspepsia, gravel, calculus, etc.

FARMVILLE LITHIA SPRINGS.

Location: Prince Edward County. Postoffice, Farmville. Access via Norfolk & Western Railway to Farmville, from which city the springs are only half a mile distant.

The springs are six in number and are beautifully situated at an altitude of 550 feet above sea-level. Four of the springs are said to have a combined flow of about 110 gallons per hour.

The water of spring No. 2 has been analyzed by Prof. E. T. Friscoe, with the following results:

Class: *Alkaline-carbonated. Lithic.*

One United States gallon of 231 cubic inches contains:

Calcium bi-carbonate	1.33	grains.
Magnesium bi-carbonate	4.49	"
Lithium carbonate	1.99	"
Manganous carbonate		trace
Ferrous carbonate	1.26	"
Sodium sulphate	3.59	"
Calcium sulphate	1.81	"
Potassium sulphate .....	.18	"
Sodium chloride	5.30	"
Alumina	2.52	"
Silica	3.92	"
Iodine		trace
Sulphuric acid		trace
Organic matter		trace
	26.39	"
Carbonic acid, free	74.2	cubic inches.

On account of the large amount of Lithium carbonate which it contains, this water is extensively used all over the country in the treatment of uric acid diathesis. It is also used with excellent effect in dyspepsia, Bright's disease, renal calculus and as a tonic.

FAUQUIER WHITE SULPHUR SPRINGS.

Location: Fauquier County. Postoffice, Fauquier White Sulphur Springs. Access by Southern railway to Warrenton, and by private conveyance to the springs, six miles distant.

This well known and important resort is beautifully situated at the base of the Blue Ridge, in one of the most attractive and prosperous sections of Virginia. The springs have been known and used as a resort since the early part of the last century, and have an interesting history. They were first brought into prominence in 1834, when two fine hotels and several cottages were built, with accommodations for 1,000 guests, and until the beginning of the war the resort enjoyed a large measure of popularity. In 1862, however, the hotels were burned, and the resort was not used for fifteen years. A handsome fire-proof hotel and cottages with accommodations for 500 guests were built in 1877, and since that time, the springs have recovered much of their old time popularity.

The following analysis by Prof. Thomas Antisell, shows the composition of the water:

Class: *Sulphureted Alkaline-chalybeate.*

One United States gallon of 231 cubic inches contains:

Calcium bi-carbonate	7.88	grains.
Magnesium bi-carbonate	2.47	"
Sodium chloride	3.75	"
Calcium sulphate	3.39	"
Iron phosphate and iron sulphate....	2.14	"
Sodium and Potassium sulphate	1.63	"
Calcium and Magnesium phosphate ..	0.64	"
Gaseous matter	0.10	"

Gases:

Total	22.00	"
Carbonic acid	11.00	cubic inches.
Sulphureted hydrogen	small quantity	

The water possesses valuable tonic, diuretic and alterative properties. It is highly recommended as a nervous tonic, and in the treatment of female troubles. As a diuretic it is found of much benefit in the incipient stages of Bright's disease, and in dropsical affections. It has also been used with much success in the various forms of dyspepsia and intestinal disorders.

THE FONTICELLO LITHIA SPRINGS.

Location: Chesterfield County. Postoffice, Richmond. Access by electric car from Richmond to the springs, near Forest Hill Park, a pleasure resort near Manchester.

The springs are not used as a resort, but the water is bottled and has an extensive sale in most of the eastern cities. It is unexcelled as a table water, but it also possesses decided therapeutic value and is much thought of for its excellent effect in gout, rheumatism and as a diuretic. It acts as a nervous sedative and on account of its extreme lightness, can be borne by the weakest stomach.

The analysis of the water by Dr. Henry Froehling, shows the following composition:

Class: *Alkaline-carbonated. Lithic...*

One United States gallon of 231 cubic inches	contains:
Magnesium bi-carbonate .....	.21636 grains.
Calcium bi-carbonate .....	.48054 "
Sodium bi-carbonate	31196 "
Ferrous bi-carbonate .....	.06205 "
Manganous carbonate	trace
Potassium sulphate .....	.20061 "
Sodium sulphate .....	.05715 "
Sodium chloride .....	.47704 "
Lithium chloride .....	.03207 "
Sodium phosphate .....	.00309 "
Sodium arsenite	trace
Sodium bromide	trace
Sodium iodide .....	.00362 "
Silica .....	.81645 "
Alumina .....	.00898 "
Carbon dioxide combined with	2.66992 "
mono-carbonates .....	.27526 "
	2.94518 "
Carbon dioxide free	6.96 cubic inches.

FOREST LODGE LITHIA SPRINGS.

Location: Hanover County. Postoffice, Glen Allen. Access by Richmond, Fredericksburg & Potomac Railway. Fifteen miles north of Richmond.

Accommodations, a modern and attractive hotel, situated in an extensive and handsome park.

The following analysis made in this laboratory shows the composition of the water:

Class: *Light Alkaline-carbonated. Lithic and Arsenical.*

One United States gallon of 231 cubic inches contains:

Magnesium carbonate .....	.48579	grains.
Calcium carbonate .....	.69980	"
Strontium carbonate .....	.00356	"
Barium carbonate .....	.00047	"
Iron (ferrous) carbonate .....	.01282	"
Manganous carbonate .....	.00064	"
Potassium sulphate .....	.19676	"
Magnesium chloride .....	.10089	"
Potassium chloride .....	.01108	"
Sodium chloride	1.33723	"
Sodium iodide .....	.00035	"
Sodium bromide .....	.00956	"
Sodium arsenite .....	.02741	"
Lithium chloride .....	.05161	"
Alumina .....	.06123	"
Silicic acid	2.07612	"
	<hr/>	
	5.07532	"
Carbon dioxide combined .....	.56160	"
	<hr/>	
	5.63692	"
Carbon dioxide free	4.62	cubic inches.

GLENOLA SPRINGS.

FORMERLY WAYLAND SPRINGS.

Location: Nottoway County. Postoffice, Jennings Ordinary.

These springs, which are distant about half a mile from Jennings Ordinary, are extensively used locally, but have not yet been developed as a resort.

The water of one of the springs has been analyzed by

Prof. M. B. Hardin, with the following results:

Class: *Light Iodid-alkaline-carbonated.*

One United States gallon of 231 cubic inches contains:		
Sodium carbonate	0.55	grains.
Lithium carbonate	0.01	"
Magnesium carbonate	0.26	"
Calcium carbonate	0.70	"
Strontium carbonate	0.03	"
Iron carbonate	0.06	"
Manganese carbonate	traces	"
Potassium sulphate	0.05	"
Potassium chloride	0.09	"
Sodium chloride	0.34	"
Sodium iodide	traces	"
Sodium nitrate	0.11	"
Sodium phosphate	0.01	"
Aluminium phosphate	0.04	"
Ammonium nitrate	traces	"
Silica	1.92	"
Aluminum silicate	0.20	"
Calcium fluoride (suspended)	traces	"
Titanium dioxide	traces	"
Organic matter	traces	"
Carbonic acid in the bi-carbonates	0.71	"
Total	5.08	"
Carbonic acid gas	6.65	cubic inches.

HARRIS' ANTI-DYSPEPTIC AND TONIC SPRINGS.

Location: Nottoway County. Postoffice, Burkeville.

The two springs at this point are located half a mile from ing houses.

Burkeville, the junction of the Norfolk & Western and Southern Railways, at an altitude of 530 feet above sea-level.

The accommodations consist of a small hotel and board-

The larger of the two springs yields about 240 gallons of water per hour, the composition of which is shown by the following analysis by Prof. E. T. Fristoe:

Class: *Light Sulphated-saline.*

One United States gallon of 231 cubic inches contains:		
Sodium hydrate (?)	0.51	grains.
Sodium chloride	0.28	"
Magnesium chloride	0.20	"

Magnesium carbonate	0.94	grains.
Magnesium sulphate	1.30	"
Calcium sulphate	0.46	"
Iron oxide	traces	"
Aluminium	0.16	"
Lithium	traces	"
Calcium carbonate	1.65	"
Nitric acid	traces	"
Organic matter	traces	"
Sulphuric acid	traces	"
Phosphoric acid	0.78	"
Silica	1.89	"
	<hr/>	
	8.17	"

This water is well known for its good effect in cases of dyspepsia and intestinal disorders.

The water of No. 2 spring has not been fully analyzed, but it contains about 10 grains per gallon of solids and is said to be a valuable ferruginous tonic. Both of these waters are bottled and shipped on order.

HARRIS' SPRING.

Location: Blackstone, Nottoway County. The water of this spring has been extensively used locally, and an analysis made in this laboratory, shows it to have the following composition: Class *Light Alkaline-carbonated. Lithic and Iodic.*

One United States gallon of 231 cubic inches contains:		
Magnesium bi-carbonate .....	.77679	grains.
Calcium bi-carbonate .....	.90276	"
Iron (ferrous) bi-carbonate .....	.04315	"
Manganous bi-carbonate .....	.00233	"
Barium bi-carbonate .....	.00426	"
Sodium bi-carbonate .....	.77505	"
Sodium chloride .....	.40006	"
Potassium chloride .....	.10030	"
Lithium chloride .....	.00362	"
Potassium sulphate .....	.10263	"
Sodium iodide .....	.00111	"
Sodium bromide	trace	"
Sodium arsenate .....	.00426	"
Calcium phosphate .....	.00139	"
Calcium fluoride	trace	"
Alumina .....	.01049	"
Silicic acid	1.13370	"
	<hr/>	
	4.26190	"
Carbon dioxide free	12.94	cubic inches.

This water is sedative and mildly alterative in its effects. It has given excellent results in cases of rheumatism, gravel, and calculus. Its lightness and the large amount of carbonic acid it contains makes it acceptable to the most delicate stomachs.

HEALING SPRINGS.

Location: Bath County. Postoffice, Healing Springs. Access by Chesapeake & Ohio Railway to Hot Springs, thence by private conveyance to the springs, a distance of three and one-half miles, over a fine boulevard.

This old and well known resort is situated in the beautiful Warm Springs Valley in the heart of the Appalachian Mountains. The valley is 2,300 feet above sea-level, and is one of greatest beauty, running for more than twelve miles, between bold and lofty mountains, and exhibiting throughout its entire length an endless variety of mountain and meadow, stream and woodland scenery, while from the crests of the mountains, the view obtained of mountain landscape, range upon range, stretching to the horizon, is unsurpassed.

The hotel and cottages are delightfully comfortable and home-like, and are connected by telephone with the depot at Hot Springs, and the hotels at Hot and Warm Springs. The surroundings have received careful study from sanitary experts, and are of the most satisfactory character.

The springs have been isolated from any possible inflow of surface water, and the ground surrounding them has been thoroughly drained. The bath-house and bottling-house are new and equipped with all modern conveniences, and no expense has been spared to make the resort charming and comfortable.

There are four principal springs on the property, the waters of which are practically identical in composition. These are:

The Pavilion Spring, supplying the drinking water for hotel and cottages.

The Bottling Springs, from which the water for shipping is obtained.

The Bath Springs, embracing a number of springs enclosed in a brick reservoir, from which the bath-house is supplied.

The Ladies' Bathing Pool, situated at the foot of the lawn and reserved for ladies and children.

The first three springs have a constant temperature of 84 degrees Far.; that of the Ladies Bathing Pool is 81.5 degrees Far.

The Healing Springs water has had a national reputation for more than a century and is now on sale throughout the country. We quote this from "The Mineral Springs of the United States and Canada," by Geo. W. Walton, M. D., New York, 1883—page 323. "It has been well named, as it finds appropriate application to all ulcerated conditions, whether of the skin or mucous membranes. In many such cases its efficacy is undoubted. The Healing Springs water will be found to be slightly hypnotic, sedative, diuretic, diaphoretic and alterative."

It also gives excellent results in chronic congestion of the liver, cystitis, and in the incipient stages of Bright's disease.

The following is an analysis of the water made by us:

Class: *Sulphate-saline. Calcic and Lithic.*

One United States gallon of 231 cubic inches contains:

Magnesium carbonate	3.13858	grains.
Calcium carbonate	20.70310	"
Strontium carbonate .....	.09309	"
Barium carbonate .....	.00705	"
Iron (ferrous) carbonate .....	.03040	"
Manganous carbonate .....	.01222	"
Zinc, lead and copper carbonates ..	trace	"
Magnesium sulphate	5.73210	"
Potassium sulphate	1.82069	"
Sodium sulphate	2.95562	"
Sodium chloride .....	.68310	"
Sodium bromide .....	.00412	"
Sodium iodide .....	.00015	"
Sodium phosphate .....	.00940	"
Lithium chloride .....	.05190	"
Rubidium chloride	trace	"
Calcium fluoride	trace	"

Alumina .....	.04320	grains.
Silica	1.36700	"
	<hr/>	
Carbon dioxide combined	36.65169	"
	10.75324	"
	<hr/>	
	47.75324	"
Carbon dioxide free	10.56	cubic inches.

Analysis of the Gas arising from the Springs:

Nitrogen	90.25	per cent.
Carbon dioxide	9.75	"
Oxygen	none	
Hydrogen sulphide	none	

HOLSTON SPRINGS.

Location: Scott County. Postoffice, Holston Springs. Access by Norfolk & Western Railway. These springs, four in number, are located amid wild and picturesque scenery at the base of Clinch Mountain, two miles from Big Moccasin Gap on the banks of the Holston River.

The following analysis by Prof. Hayden, shows the composition of the water:

Class *Sulphated-saline-calcic.*

One United States gallon of 231 cubic inches contains:

Calcium carbonate	6.40	grains.
Sodium chloride and Ammonium chloride	1.52	"
Sodium sulphate	trace	"
Magnesium sulphate	12.72	"
Calcium sulphate	20.48	"
Aluminium sulphate	trace	
Alluminium phosphate	trace	

41.12 "

Temperature of water 68.50 degrees Far.

HUBBARD SPRINGS.

Location: Lee County. Postoffice, Jonesville. Access by Louisville & Nashville Railway to Hubbard Springs Station, near which the springs are located.

The springs are located in a wild region of country on foot hills of the Cumberland Mountains, at an elevation of 1,450 feet.

There are four springs known as the "White Sulphur," the "Black Sulphur," the "Chalybeate" and the "Freestone."

No analyses of these waters are recorded, but they are said to be valuable and much esteemed in the treatment of gout, rheumatism, liver and stomach troubles.

Accommodation for visitors can be obtained at houses in the vicinity.

HUNTER'S PULASKI ALUM SPRINGS.

Location: Pulaski County. Postoffice, Sassin. Access by Norfolk & Western Railway to Pulaski, and by private conveyance eight and one-half miles to the springs, which are located in the midst of beautiful mountain scenery.

The altitude of the springs is about 2,000 feet above sea-level.

The analysis of the water by Dr. Wm. H. Taylor, shows the following composition:

Class: *Aluminous. Chalybeate.*

One United States gallon of 231 cubic inches contains:

Potassium sulphate	0.31	grains.
Sodium sulphate	0.32	"
Lithium sulphate	trace	"
Calcium sulphate	0.99	"
Magnesium sulphate	1.26	"
Aluminium sulphate	16.40	"
Iron sulphate	1.99	"
Manganese sulphate	trace	"
Sodium chloride	0.11	"
Silica	3.87	"
Free sulphuric acid	0.63	"
	25.88	"

The analysis is accompanied by the statement from the chemist that the above does not represent a complete analysis, and that further determinations would doubtless reveal other ingredients.

The water has given good results in cases of diarrhoea, dysentery and dyspepsia. It is highly recommended for catarrhal

conditions of the mucous membranes and for scrofulous and other eruptions. It is bottled and shipped on order.

IRON LITHIA SPRINGS.

Location: Tazewell County. Postoffice, Tazewell. Access by Norfolk & Western Railway to Tip Top Station, thence by private conveyance to the springs, two miles distant.

These springs are of recent discovery, but seem destined to become of importance on account of the unusual valuable character of the water, and the picturesque and beautiful location.

The springs are five in number, and are situated at an elevation of 2,700 feet above sea-level in the Alleghany Mountains. They have a flow of about 1,000 gallons of water daily.

The following analysis made in this laboratory shows the composition of the water:

Class: *Sulphated-saline. Aluminous, Manganous-chalybeate and Lithic.*

One United States gallon of 231 cubic inches contains:

Magnesium sulphate	4.71 grains.
Calcium sulphate	1.71 "
Barium sulphate	0.09 "
Strontium sulphate	trace
Iron sulphate	5.08 "
Manganese sulphate	0.36 "
Aluminium sulphate	8.05 "
Potassium sulphate	0.51 "
Sodium sulphate	0.25 "
Lithium chloride	0.18 "
Sodium chloride	0.39 "
Sodium iodide	trace
Aluminium phosphate	0.11 "
Sulphuric acid (free)	0.51 "
Silicic acid	1.60 "
Total	23.55 "
Carbonic acid gas	5.20 cubic inches.

This water is a fine aluminous-chalybeate containing enough manganese to make it particularly valuable as a tonic in certain female troubles, and has given good results in cases of this kind and in diarrhoea, dysentery and general debility.

JEFFERSON PARK SPRING.

Location: Albemarle County. Postoffice, Charlottesville. Access via Chesapeake & Ohio, or Southern Railroads to Charlottesville, then by electric car or carriage to the hotel two miles distant.

The hotel is beautifully situated near the University of Virginia, and is fully equipped with all modern conveniences for comfort and amusement.

The spring has been well known locally for years, and highly esteemed for its tonic properties.

An analysis by Prof. F. P. Dunnington, gave the following results:

Class: *Chalybeate...Saline.*

One United States gallon of 231 cubic inches contains:

Carbonate of iron .....	.843	grains.
Sulphate of lime .....	.409	"
Sulphate of soda526	"
Chloride of sodium217	"
Chloride of potassium025	"
Silica	1.102	"
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	3.122	"

JORDAN'S WHITE SULPHUR SPRINGS.

Location: Frederick County. Postoffice, Jordan's Springs. Access by Baltimore & Ohio Railway to Stephenson's Depot, and thence by private conveyance to the springs, two miles distant.

These springs are situated at an altitude of 1200 feet above sea-level, in the northern part of the Shenandoah Valley, about six miles from Winchester.

A modern hotel with all recent improvements, and a bathhouse recently built, provide excellent accommodation and bathing facilities.

The composition of the water, as shown by an analysis made by Dr. Thomas Antisell, is as follows:

Class: *Alkaline-sulphureted.*

One United States gallon of 231 cubic inches contains:

Calcium sulphate	5.13	grains.
Potassium sulphate	2.09	"
Sodium chloride	0.76	"
Potassium carbonate	9.71	"
Magnesium carbonate	2.88	"
Iron carbonate	trace	"
Manganese carbonate	0.01	"
Hydro-sulphuric acid	0.79	"
Silicic acid	0.25	"
Alumina	0.01	"

Total	21.63	"
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The medicinal value of this water has been known and appreciated for many years.

It is diuretic, aperient, tonic and alterative in its action, and has been largely and successfully used in kidney, liver, and stomach trouble. It is also highly recommended for the treatment of gout and rheumatism.

It is on the market commercially, and is obtainable in any desired quantity.

LEAKE'S MANGANESE CHALYBEATE WATER.

Location: Goochland County. Postoffice, Irvin. Access by the James River Division of the Chesapeake & Ohio Railway and thence by private conveyance to the springs. No hotel accommodation at present.

A recent analysis by us shows the water to have the following composition:

Class: *Alkaline Manganiferous-chalybeate.*

One United States gallon of 231 cubic inches contains:

Iron (ferrous) carbonate	1.7278	grains.
Manganous carbonate .....	.7133	"
Calcium carbonate	1.6117	"
Magnesium carbonate .....	.7641	"
Sodium carbonate .....	.0432	"
Potassium sulphate .....	.2117	"
Sodium sulphate .....	.0763	"
Sodium chloride .....	.5331	"
Sodium phosphate .....	.0215	"

Sodium iodide .....	.0006	grains.
Silica .....	.8265	"
Alumina .....	.1684	"
Organic matter .....	.1750	"
	6.8732	"
Carbon dioxide combined with mono- carbonates forming bi-carbonates	2.0574	"
	8.9306	"

Carbon dioxide free 6.75 cubic inches.

This water has particular value as a uterine tonic on account of the unusually large proportion of iron and manganese carbonates it contains, and has also been found very beneficial in all cases resulting from an impoverished condition of the blood.

Another spring on the same property, analyzed by Dr. Henry Froehling, has the following composition:

Class: *Light Alkaline-carbonated. Lithic.*

One United States gallon of 231 cubic inches contains:

Magnesium carbonate	1.34773	grains.
Calcium carbonate	1.52851	"
Strontium carbonate .....	.01049	"
Barium carbonate .....	.00233	"
Iron (ferrous) carbonate .....	.06765	"
Manganous carbonate .....	.03674	"
Zinc, nickel and copper	trace	"
Calcium sulphate .....	.48404	"
Potassium sulphate .....	.17612	"
Sodium sulphate .....	.55985	"
Sodium chloride .....	.76980	"
Sodium iodide .....	.00058	"
Sodium bromide .....	.01516	"
Sodium phosphate	trace	"
Lithium chloride .....	.07523	"
Alumina .....	.03497	"
Silicic acid	3.06735	"
	8.17675	"
Carbon dioxide combined	1.37805	"
	9.55480	"

Carbon dioxide 14.3 cubic inches.

This water is remarkable for its organic purity and furnishes an excellent table water.

The composition of its mineral constituents give it consid-

erable medicinal value in cases of gout, rheumatism, disordered digestion and nervous affections.

MAGEE'S CHLORINATED LITHIA WATER.

Location: Mecklenburg County. Postoffice, Clarksville.
Access by Southern Railway to Clarksville.

There are two springs on the property, the waters of which are practically identical in composition, differing only slightly in the quantity of their mineral constituents.

Analysis of these waters made in this laboratory in 1896. gave the following composition:

Class: *Chlorinated Calcic and Lithic.*

One United States gallon of 231 cubic inches contains:

	No. 1.	No. 2.
Magnesium bi-carbonate	6.92759 grains.	6.54561 grains.
Calcium bi-carbonate	4.99377 "	4.77741 "
Strontium bi-carbonate . . . . .	.04782 "	.03849 "
Barium bi-carbonate . . . . .	.04957 "	.04898 "
Iron (ferrous) bi-carbonate . . . . .	.02683 "	.03499 "
Manganous bi-carbonate . . . . .	.00175 "	.00116 "
Magnesium chloride . . . . .	.95466 "	.60884 "
Calcium chloride	4.52898 "	3.39936 "
Sodium chloride	4.93195 "	4.40243 "
Lithium chloride . . . . .	.04315 "	.03207 "
Potassium sulphate . . . . .	.58551 "	.46829 "
Sodium sulphate . . . . .	.74122 "	.62459 "
Sodium bromide . . . . .	.03441 "	.02916 "
Sodium iodide . . . . .	.00029 "	.00023 "
Sodium arsenate	trace	trace
Sodium phosphate . . . . .	.07406 "	.05249 "
Sodium bi-borate	trace	trace
Alumina . . . . .	.04432 "	.03033 "
Silica	2.68845 "	1.17219 "
	26.67433 "	22.26662 "
Carbon dioxide gas (free)	14.33 cu. in.	11.10 cu. in.

These waters have a specific action in scrofula, blood and skin diseases, catarrhal affections and all diseases requiring an alterative tonic.

MASSANETTA SPRINGS.

Location: Rockingham County. Postoffice, Harrisburg.

Access by Baltimore & Ohio Railway to Harrisburg, and by private conveyance to the springs, four and one-half miles distant.

The springs are situated near Massanutten Mountain in the Shenandoah Valley, and the hotel and cottages are beautifully located at an altitude of 1,350 feet above sea-level. The resort has been known for many years, and the waters are regarded almost as a specific for malarial poisoning.

The water is fine alkaline chalybeate, and gives excellent results in cases of anaemia, chlorosis and other conditions consequent upon an impoverished condition of blood.

The following analysis by Prof. J. W. Mallet, shows its composition:

Class: *Alkaline chalybeate.*

One United States gallon of 231 cubic inches contains:

Calcium carbonate	12.10	grains.
Magnesium carbonate	5.78	"
Iron carbonate	3.12	"
Manganese carbonate	0.43	"
Sodium carbonate	0.93	"
Lithium carbonate	trace	
Ammonium chloride	trace	
Potassium chloride	0.13	"
Potassium sulphate	0.09	"
Calcium sulphate	0.35	"
Alumina	0.13	"
Arsenious oxide (in salt)	trace	
Phosphoric acid	trace	
Silica	0.94	"
Organic matter	0.40	"
	<hr/>	
	24.40	"
Carbonic acid united to carbonates as above to form acid salts	8.80	"
Temperature of water 55 degrees Far.		

MILLBORO SPRINGS.

Location: Bath County. Postoffice, Millboro. Access by Chesapeake & Ohio Railway to Millboro, and by carriage two miles to the springs.

The springs are located at an elevation of 2,000 feet above sea-level and hotel and sanitarium accommodation for about 100

guests is provided. There are several springs on the grounds consisting of sulphur and alkaline waters.

An analysis of the sulphur water by G. B. M. Zerr, in 1891, gave the following results:

Class: *Light Alkaline-sulphated.*

One United States gallon of 231 cubic inches contains:

Sodium hydro-sulphate	3.34	grains.
Calcium sulphate	1.55	"
Potassium sulphate	0.11	"
Sodium bi-carbonate	4.27	"
Magnesium bi-carbonate	1.65	"
Calcium bi-carbonate	0.54	"
Iron bi-carbonate	trace	"
Alumina	0.26	"
Sodium silicate	0.89	"
Sodium chloride	0.47	"
Aluminium phosphate	trace	"
Organic matter	0.35	"
	13.43	"

Gases:

Sulphureted hydrogen	1.08	cubic inches.
Carbonic acid	6.94	" "

This water presents a valuable combination of sulphurets and carbonates, and is tonic, anti-acid, and mildly diuretic in its action.

It is used with good results in acid dyspepsia, gout and rheumatism, liver and kidney troubles.

MONTGOMERY WHITE SULPHUR SPRINGS.

Location: Montgomery County. Postoffice, Montgomery Springs. Access by Norfolk & Western Railway to Big Tunnel Station, from which point a narrow gauge branch railroad runs to the springs.

Excellent hotel and cottage accommodations are found at this well known and attractive resort, situated in the Alleghanies, 2,000 feet above sea-level. The scenery in the neighborhood is beautiful and picturesque, and many interesting localities are within reach.

The waters are of three kinds—sulphur, chalybeate and

freestone. No complete analyses are available, but the White Sulphur water is mildly diuretic, diaphoretic and laxative in its action, and is used with excellent results in skin diseases, disorders of the liver and spleen, gout and rheumatism.

The Chalybeate spring is rich in carbonates of iron, lime,, magnesia and lithia, and constitutes a valuable tonic used with much benefit in all conditions where an alkaline chalybeate water is applicable.

MOUNT ELLIOT SPRINGS.

FORMERLY VARIETY SPRINGS.

Location: Augusta County. Postoffice, Variety Springs.
Access by Chesapeake & Ohio Railway to Variety Springs.

This charming resort is located at an altitude of 235 feet on the North Mountain range of the Alleghanies. The accommodations consist of a large modern hotel and cottages with a capacity of 200 guests, well equipped with modern conveniences for comfort and amusement. The bathing facilities include hot and cold healing baths and plunge baths.

There are a variety of mineral waters on the springs property, the most important of which are the "Ferro-Manganic" and "Alun" springs.

The following analysis of the Ferro-Manganic water by Mr. Charles Catlett, shows it to be a valuable chalybeate, containing a noticeable amount of manganese, and its use in cases of anaemia, chlorosis, and general debility is attended with marked benefit:

Class: *Chalybeate-Manganous.*

One United States gallon of 231 cubic inches contains:

Sodium chloride .....	.071	grains.
Sodium sulphate .....	.992	"
Potassium sulphate .....	.752	"
Ferrous (iron) phosphate .....	.025	"
Ferrous silicate .....	.353	"
Ferrous bi-carbonate	1.740	"

Manganous carbonate .....	.171	grains.
Magnesium sulphate	2.520	"
Calcium (lime) sulphate	5.916	"
Calcium bi-carbonate	2.690	"
Silica .....	.998	"
Nitrates		trace
Free Ammonia		trace
Organic matter		trace
Alumina		trace
	<hr/>	
	16.228	"

Gases:

Sulphureted hydrogen	trace
Free carbonic acid	13.89 cubic inches.
Air not determined.	

According to an analysis by Prof. Wm. Gilliam, the Alum Spring has the following composition:

Class: *Acid-chalybeate. Aluminous.*

One United States gallon of 231 cubic inches contains:

Calcium sulphate	13.33	grains.
Magnesium sulphate	11.64	"
Potassium sulphate	0.29	"
Aluminium sulphate	34.41	"
Iron phosphate	5.11	"
Sodium chloride	0.29	"
Silica	1.13	"
Sulphuric acid	1.37	"
	<hr/>	
	67.57	"

NYE LITHIA SPRINGS.

Location: Wythe County. Postoffice, Wytheville. Access by Norfolk & Western Railway to Wytheville, thence by carriage to the springs, two miles distant.

Excellent hotel and boarding-house accommodation can be had in Wytheville.

The three springs, two lithia and one chalybeate, are located at the elevation of 2,360 feet in a tract of eighteen acres of primeval oak, and in a neighborhood widely known as a health resort.

The lithia waters are held in high esteem in the treatment of

gout, rheumatism, stomach and intestinal disorders.

The following analysis of No. 1 Lithia Spring, is by W. L. Dudley, and shows an extremely high amount of lithia:

Class: *Alkaline-lithic.*

One United States gallon of 231 cubic inches contains:

Calcium carbonate	10.63	grains.
Lithium carbonate	6.41	"
Iron and alumina oxide .....	.31	"
Silicic acid	1.19	"
	<hr/>	
	18.54	"

The chalybeate water gives good results and is recommended in female troubles consequent upon anaemia, and as a general tonic.

An analysis by J. L. Jarman, shows the following composition:

Class: *Alkaline-chalybeate. Lithic-calcic.*

One United States gallon of 231 cubic inches contains:

Potassium carbonate .....	.01	grains.
Sodium carbonate .....	.81	"
Lithium carbonate	1.89	"
Calcium carbonate	11.60	"
Magnesium carbonate	2.35	"
Iron and Alumina oxide	1.33	"
Silicic acid .....	.66	"
	<hr/>	
	18.65	"

ORKNEY SPRINGS.

Location: Shenandoah County. Postoffice, Orkney Springs. Access by Baltimore & Ohio Railway to Mount Jackson, and thence by coaches to the springs, twelve miles distant.

The Orkney Springs, situated at an altitude of 2,300 feet above sea-level are one of the oldest resorts in Virginia, though little permanent improvement was made until 1874, when a good hotel with accommodation for 750 guests, was built.

The following analysis by Prof. J. W. Mallet, show the composition of three waters:

One United States gallon of 231 cubic inches contains:

	"Healing."	"Powder."
	Class: Alkaline-carbonated.	Class: Alkaline-carbonated. Sulphureted.
Calcium carbonate	9.925 grains.	4.589 grains.
Magnesium carbonate 1.361	"	3.543 "
Iron carbonate . . . . .	.563 "	.260 "
Manganese carbonate..	.007 "	.020 "
Sodium carbonate . . . . .	.016 "	3.903 "
Lithium carbonate, dis.	trace	trace
Potassium chloride ...	.036 "	0.030 "
Sodium chloride . . . . .	.146 "	.425 "
Ammonium chloride	—	trace
Calcium fluoride ..faint	trace	trace
Calcium phosphate (tri-basic) . . . . .	.014 "	.002 "
Barium sulphate	—	" dist. trace
Strontium sulphate ...	—	" faint trace
Calcium sulphate	1.376 "	2.109 "
Potassium sulphate ...	.228 "	.194 "
Aluminium sulphate ...	.036 "	.021 "
Silica	1.003 "	1.662 "
Copper sulphate	—	—
Sodium sulphide (Na ₂ S)...	—	.528 "
Arsenic	—	" distant trace in sediment
Organic matter	—	" trace
Carbonic.. anhydride (united to carbonates, as above, to form acid carbonates)	5.303 "	5.602 grains.
	20.014 "	22.888 "

Class: *Acid-chalybeate. Lithic.*

Spring No. 2, Bear Wallow.

One United States gallon of 231 cubic inches contains:

Potassium chloride . . . . .	.079	grains.
Sodium chloride . . . . .	.018	"
Ammonium chloride	trace	
Sodium iodide	trace	
Calcium phosphate (tribasic) . . . . .	.008	"
Calcium sulphate . . . . .	.862	"
Potassium sulphate . . . . .	.251	"
Lithium sulphate . . . . .	.074	"
Magnesium sulphate	2.935	"
Aluminium sulphate . . . . .	.065	"
Iron (ferrous) sulphate	5.451	"
Manganese (manganous) sulphate....	.017	"
Copper sulphate	distinct	trace

Sulphuric acid (free) .....	.426	grains.
Silica	1.847	"
Arsenic	trace in sediment	"
Organic matter .....	.072	"
	<hr/>	
	12.196	"

The various waters have been found beneficial in a large variety of diseases. The two alkaline waters give excellent results in stomach, kidney and liver troubles, while the acid chalybeate is very valuable in chlorosis and other female functional derangements, and as a tonic in all cases consequent upon anaemia or general debility.

OTTERBURN LITHIA SPRINGS.

Location: Amelia County. Postoffice, Otterburn Springs.
Access by Southern Railway to Otterburn Station.

The springs are located in a pleasant grove and a modern, well kept hotel provides good accommodation.

An analysis of the water, made in this laboratory, gave the following results:

Class: *Light Alkaline-carbonate. Lithic.*

One United States gallon of 231 cubic inches contains:

Magnesium carbonate	1.48827	grains.
Calcium carbonate	2.43769	"
Iron (ferrous) carbonate .....	.13646	"
Sodium carbonate .....	.26009	"
Lithium carbonate .....	.03615	"
Magnesium chloride .....	.05656	"
Sodium chloride .....	.40647	"
Sodium sulphate .....	.08572	"
Potassium sulphate .....	.08047	"
Sodium iodide .....	.00699	"
Sodium bromide	trace	"
Alumina .....	.03616	"
Silica	2.44352	"
	<hr/>	
	7.47455	"
Carbon dioxide combined	2.38812	"
	<hr/>	
	9.86267	"
Carbon dioxide free	18.4	cubic inches.

The water has for many years held a high position and has

an extensive sale, as a table water. Medicinally it has been largely used with marked success in acid dyspepsia, gout, and rheumatism.

Taken in quantity, it has a mildly tonic and alterative action.

PALMERS SPRINGS LITHIA WATER.

Location: Mecklenburg County. Postoffice, Palmers Springs.

This water has been on the market for the last eight years and during that time has earned quite a reputation for its curative effect in scrofula, anaemia, dyspepsia, excessive menstruation and as a uterine tonic.

An analysis of the water, made by Dr. Henry Froehling, gave the following results:

Class: *Alkaline-carbonated. Lithic.*

One United States gallon of 231 cubic inches contains:

Magnesium carbonate	1.30632	grains.
Strontium carbonate	traces	"
Calcium carbonate	1.92683	"
Iron (ferrous) carbonate .....	.31258	"
Manganous carbonate .....	.05482	"
Sodium carbonate .....	.35107	"
Potassium sulphate .....	.54702	"
Sodium sulphate .....	.14988	"
Sodium chloride .....	.68524	"
Sodium iodide .....	.00094	"
Sodium bromide .....	.00041	"
Sodium arsenate	trace	"
Sodium phosphate .....	.01755	"
Lithium chloride .....	.05365	"
Alumina .....	.02916	"
Silica	2.67006	"
	<hr/>	
	8.10643	"
Carbon dioxide combined with mono-carbonates to form bi-carbonate	1.67314	"
	<hr/>	
	9.77957	"
Carbon dioxide gas, free	14.9	cubic inches.

THE PINEY MOUNTAIN MINERAL SPRINGS.

Location: Washington. County. Postoffice, Bristol. Access by Norfolk & Western Railway to Bristol, thence by electric car or private conveyance to the springs, two and a half miles distant.

No hotel has yet been built at the springs, which are beautifully situated on Piney Mountain, near the Virginia-Tennessee line, but good hotel and boarding-house accommodation can be had in Bristol.

The water is a very valuable one, as shown by the following analysis made in this laboratory:

Class: *Acid-aluminous-chalybeate. Sulphated-saline.*

One United States gallon of 231 cubic inches contains:

Magnesium sulphate	18.54512	grains.
Calcium sulphate	13.76072	"
Strontium sulphate .....	.02508	"
Barium sulphate .....	.01633	"
Iron (ferrous) sulphate	20.70231	"
Manganous sulphate	1.23284	"
Nickel sulphate	trace	"
Aluminium sulphate	10.29313	"
Potassium sulphate .....	.46946	"
Sodium sulphate .....	.43972	"
Sodium chloride	1.94782	"
Sodium iodide .....	.00041	"
Sodium bromide	—	"
Sodium arsenate .....	.02531	"
Lithium chloride .....	.09447	"
Aluminium phosphate .....	.03791	"
Silicic acid	1.19552	"
Sulphuric acid, free	3.57431	"

72.36046 "

Carbon dioxide free 25.81 cubic inches.

This is a sulphated acid chalybeate water of great potency, and presents a valuable combination of mineral ingredients.

In addition to its richness in iron it contains a notable amount of manganous sulphate, which ingredient is of particular benefit, as an alterative and tonic in all cases characterized by anaemia and general debility. It is also used with much success in stomach and intestinal troubles, and locally as an astringent and tonic by spray, gargle or douche.

POWHATAN LITHIA AND ALUM SPRINGS.

Location: Powhatan County. Postoffice, Tobaccoville. Access by Farmville & Powhatan Railway to Tobaccoville, and by private conveyance to the springs, three-quarters of a mile distant.

Two springs are found on the property, known respectively, as the "Lithia" and the "Alum" springs. No quantitative analysis is recorded.

The water is for sale, but no development has been made for the accommodation of guests.

RAWLEY SPRINGS.

Location: Rockingham County. Postoffice, Rawley Springs. Access by Baltimore & Ohio Railway to Harrisonburg, thence by stage or private conveyance to the springs, eleven miles distant, over an excellent turnpike.

This old and well known resort, with its substantial and comfortable hotel, is situated amid wild and picturesque scenery at an altitude of 2,000 feet above sea-level. The hotel has a capacity of 150 guests, and is fully equipped with all modern conveniences.

There are several springs on the property, one of which has been analyzed by Prof. J. W. Mallet, with the following results:

Class: *Light carbonated-chalybeate.*

One United States gallon of 231 cubic inches contains:

Protoxide of iron	1.3214	grains.
Protoxide of manganese .....	.0122	"
Alumina .....	.0514	"
Magnesia .....	.3874	"
Lime .....	.3536	"
Lithia (detected by spectroscope) ..	trace	
Soda .....	.3068	"
Potash .....	.0721	"
Ammonia	trace	
Sulphuric acid .....	.5208	"
Chlorine .....	.0315	"
Silicic acid .....	.8163	"

Carbonic acid (combined)	1.5624 grains.
Organic matter (including humoid acids) .....	.3531 "
The gases dissolved are as follows:	
Carbonic acid	7.42 cubic inches.
Oxygen	2.07 " "
Nitrogen	4.18 " "

This water has the composition of a pure light chalybeate and is of considerable value as a tonic in the treatment of anaemic conditions. It is extensively sold in different cities.

ROANOKE RED SULPHUR SPRINGS.

Location: Roanoke County. Postoffice, Red Sulphur Springs. Access by Norfolk & Western Railway to Salem, thence by private conveyance to the springs, nine miles distant.

Excellent hotel and cottage accommodation is found at this charming resort, situated at an altitude of 2,100 feet above sea-level, twelve miles from Roanoke City.

The surrounding mountain scenery is beautiful, and excellent trout fishing and hunting are obtainable in the neighborhood.

The water has been analyzed by Prof. M. B. Hardin, with the following results:

Class: *Alkaline-carbonated. Sulphureted.*

One United States gallon of 231 cubic inches contains:

Calcium carbonate	6.54 grains.
Magnesium carbonate	5.83 "
Lithium carbonate	0.02 "
Manganese carbonate	0.02 "
Iron carbonate	0.06 "
Copper carbonate	trace
Sodium chloride	0.24 "
Ammonium chloride	0.02 "
Calcium chloride	0.03 "
Lead sulphate	trace
Barium sulphate	trace
Strontium sulphate	1.71 "
Calcium sulphate	2.10 "
Sodium sulphate	3.04 "
Potassium sulphate	0.33 "
Sodium hyposulphite	0.03 "

Ammonium nitrate	0.05	grains.
Alumina	trace	"
Silica	0.83	"
Organic matter	0.76	"
Arsenic	trace	"
<hr/>		
Total	21.70	"
Carbonic anhydride combined with mono-carbonates to form bi- carbonates	5.96	"
<hr/>		
Total	27.66	"

Gases:

Carbonic acid	12.40	cubic inches.
Sulphureted hydrogen	2.44	" "

Within a few hundred feet of the Sulphur springs a good chalybeate spring arises. The water has been analyzed in this laboratory with the following results:

Class: *Alkaline-chalybeate. Carbonated.*

Calcium carbonate	0.45	grains.
Magnesium carbonate	0.95	"
Iron carbonate	2.09	"
Manganese carbonate	0.09	"
Sodium carbonate	0.44	"
Ammonium carbonate	traces	"
Sodium chloride	0.27	"
Potassium sulphate	0.20	"
Sodium sulphate	0.08	"
Aluminium sulphate	0.05	"
Aluminium phosphate	0.02	"
Silica	0.50	"
Organic matter	0.60	"
<hr/>		
Total	5.20	"
Carbonic acid to form bi-carbonates..	2.00	"
<hr/>		
Total	7.20	"

The water of the sulphur spring is believed to be of value in the treatment of bronchial, pulmonary and throat troubles, and the resort is much frequented by patients of this class.

The water of the chalybeate spring, is an **active** tonic, valuable in all debilitated conditions.

ROCKBRIDGE ALUM SPRINGS.

Location: Rockbridge County: Postoffice, Rockbridge Alum Springs. Access by Chesapeake & Ohio Railway to Gaston Station, thence by private conveyance to the springs.

These important and valuable alum springs—among the best of the kind known, originate in the large masses of alum shale, which constitute a characteristic feature of the geology of this neighborhood. They are beautifully located at an altitude of 2,500 feet between the spurs of North and Mill Mountains amid charming scenery, and every effort has been made to make the resort one of the finest in the State. The hotel and cottage accommodation is excellent.

The various springs on the property vary considerably in the proportion of the different ingredients present, as is shown by the following analyses of a number of waters. (U. S. Geo. Sur. Bulletin 32):

Class: *Acid-chalybeate. Aluminous.*

One United States gallon of 231 cubic inches contains:

	No. 1	No. 2	No. 4	No. 6	No. 7.
	Grains.	Grains.	Grains.	Grains.	Grains.
Sodium sulphate	0.02	0.03	0.03	0.18	0.23
Calcium sulphate	1.73	3.23	2.32	0.29	3.31
Lithium sulphate	0.02	0.02	0.03	0.01	0.02
Magnesium sulphate ...	0.89	5.61	7.36	2.65	9.22
Potassium sulphate	0.17	0.41	0.18	0.25	0.27
Aluminium sulphate ...	31.25	42.61	72.37	6.88	81.05
Manganese sulphate ..	0.86	0.09	1.37	0.31	1.03
Iron protosulphate				0.23	0.52
Iron persulphate	1.02	1.95	2.90	1.84	5.17
Nickel sulphate	0.06	0.14	0.23	0.12	0.46
Cobalt sulphate	0.03	0.02	0.08	0.09	0.31
Copper sulphate				0.11	6.08
Zinc sulphate	0.12	0.39	0.22	0.03	0.61
Lead sulphate	trace	trace	trace		
Ammonium nitrate ...	trace	trace	trace		
Calcium phosphate ...	0.02	0.15	0.05	trace	0.01
Ammonium crenate ...					
Sodium chloride	0.08	0.11	0.14	0.01	0.08
Calcium fluoride	trace	trace	trace	trace	trace
Antimony	trace	trace	trace	trace	trace

	Grains.	Grains.	Grains.	Grains.	Grains.
Copper	0.04	0.04	0.10		
Iron oxide					
Arsenic	trace	trace	trace		
Alumina					
Silica	3.54	3.70	4.38	2.80	3.03
Sulphuric acid	3.24	3.83	3.07	2.14	4.84
Carbonic acid					
Organic matter	trace	trace	trace	trace	trace
	<u>43.09</u>	<u>62.35</u>	<u>94.83</u>	<u>17.94</u>	<u>116.27</u>
Gases:					
	cu. in.	cu. in.	cu. in.	cu. in.	cu. in.
Oxygen	1.53	1.49	4.12	1.27	1.11
Nitrogen	4.19	3.98	1.64	3.62	3.19
Carbon dioxide	12.37	10.89	12.72	11.39	10.38

The waters are of great value in all cases where a strong astringent chalybeate is indicated, and give excellent results in dysentery, chronic diarrhœa, leucorrhœa and catarrhal affections of the mucous membranes. Local application of the water in scrofulous and syphilitic eruptions, is also attended with much benefit, and in such cases, its combined internal and local use frequently produces a permanent cure.

ROCK ENON SPRINGS.

Location: Frederick County. Postoffice, Rock Enon Springs. Access by Valley Branch of Baltimore & Ohio Railway to Winchester, from which point the springs, distant sixteen and one-half miles, are reached by coach.

A number of springs of different kinds, some of which have been known and used for a long time, are found in the immediate neighborhood of this attractive resort. The hotel is a fine one, located at an altitude of 1,200 feet above sea-level, in a narrow valley of the North Mountain. It is surrounded by virgin forest, and is provided with every convenience for comfort and recreation.

Three mineral springs occur on the property—chalybeate, alkaline, and sulphur in character. The former has been analyzed, by Professors Gale and New, with the following results:

Class: *Chalybeate. Sulphated-saline.*

One United States gallon of 231 cubic inches contains:

Sodium carbonate	1.21	grains.
Calcium carbonate	5.13	"
Calcium sulphate	3.56	"
Magnesium sulphate	12.89	"
Magnesium chloride	1.12	"
Iron oxide	14.25	"
Manganese oxide	1.05	"
Alumina	0.80	"
Silica	0.42	"
Total	40.43	"

The analysis shows this to be a good chalybeate. Its action is aperient and diuretic, and it has excellent tonic effect in cases of anaemia or general debility.

The waters of the alkaline and sulphur springs have not been fully analyzed, but the former is said to possess anti-acid, diuretic and aperient properties, and to give good results in the treatment of diseases of the kidneys and stomach, as well as gout and rheumatism and skin diseases.

ROCKINGHAM VIRGINIA SPRINGS.

Location: Rockingham County. Postoffice, McGahetsville. Access by Norfolk & Western Railway to Elkton Station, and by private conveyance to the Springs, five miles distant.

The springs are located amid rugged mountain scenery near the eastern base of the Massautten, at an elevation of over 2,000 feet. The accommodations for guests are a hotel and cottages.

An analysis of the water from Spring No. 3, made by Dr. Henry Froehling, in 1898, gave the following results:

Class: *Alkaline-carbonated. Lithic.*

One United States gallon of 231 cubic inches contains:

Magnesium carbonate	2.50088	grains.
Calcium carbonate	6.44998	"
Strontium carbonate .....	.03966	"
Barium carbonate .....	.00525	"
Iron (ferrous) carbonate .....	.00991	"
Manganous carbonate .....	.00233	"
Magnesium sulphate .....	.43476	"

Calcium sulphate	3.96562	grains.
Potassium sulphate	1.92069	"
Sodium chloride .....	.68232	"
Lithium chloride .....	.07581	"
Sodium iodide .....	.00039	"
Sodium bromide .....	.00408	"
Sodium arsenate	trace	"
Calcium fluoride	trace	"
Alumina .....	.04199	"
Silica	2.03530	"
	18.16877	"
Carbon dioxide combined	4.14756	"
	22.31635	"

Carbon dioxide free 14.69 cubic inches.

The water is well known as a remedy for dyspepsia, liver and kidney troubles, as an alterative and nervine tonic.

SEVEN SPRINGS.

Location: Washington County. Postoffice, Glade Springs. Access by Norfolk & Western Railway to Glade Springs, from which point the springs are distant two miles.

No accommodations for guests exist at the springs.

The residue from the evaporation of the water, known commercially as "Seven Springs Iron and Alum Mass" is on the market, but it is to be regretted that the springs have not been developed, as the water is a valuable one.

The following analysis by Prof. Mallet, shows its composition:

Class: *Sulphated-saline. Chalybeate. Aluminous.*

One United States gallon of 231 cubic inches contains:

Sodium sulphate	0.23	grains.
Calcium sulphate	17.54	"
Lithium sulphate	0.02	"
Magnesium sulphate	16.00	"
Potassium sulphate	0.06	"
Strontium sulphate	trace	"
Aluminium sulphate	15.22	"
Ammonium sulphate	0.02	"
Manganese sulphate	0.26	"
Iron protosulphate	0.41	"
Iron persulphate	4.63	"

Nickel sulphate	0.16	grains.
Cobalt sulphate	0.01	"
Copper sulphate	0.01	"
Zinc sulphate	0.30	"
Calcium phosphate	trace	"
Sodium chloride	0.33	"
Calcium fluoride	trace	"
Silica	1.50	"
Organic matter	0.76	"
	<hr/>	
	21.71	"

SWEET CHALYBEATE SPRINGS.

Location: Alleghany County. Postoffice, Sweet Chalybeate Springs. Access by the Chesapeake & Ohio Railway to Alleghany Station, thence by carriage to the springs, nine miles distant.

This typical Virginia Mountain resort is beautifully situated in the heart of the Alleghany Mountains, at an altitude of 3,000 feet above sea-level. The valley in which the springs are located, is one of the most beautiful in the State, and the surrounding country presents in a marked degree all the charm of the mountain region of Virginia.

Deer and other game abound, and excellent fishing may be had in the streams of the neighborhood. The hotel is commodious and well arranged and the bathing facilities include hot and cold mineral water baths and enclosed plunge bathing pools.

The four springs have a combined flow of 48,000 gallons per hour, and a temperature of 75 degrees Far.

The following analysis of the water of the Red Spring, by Prof. W. B. Rogers, shows the general composition of all the springs:

Class: *Calcic-chalybeate.*

One United States gallon of 231 cubic inches contains:

Magnesium carbonate	2.70	grains.
Sodium sulphate	3.23	"
Calcium sulphate	32.88	"
Magnesium sulphate	7.18	"
Sodium chloride	0.09	"

Magnesium chloride	1.57	grains.
Calcium chloride ...	0.02	"
Iron sesquioxide	0.73	"
Total	48.40	"

Gases:

Carbonic acid	106.46	cubic inches
Sulphureted hydrogen	trace	
Oxygen	0.46	" "
Nitrogen	0.59	" "

The water is used with excellent effect in all diseases resulting from an impoverished condition of the blood.

SWINEFORD ARSENIC LITHIA SPRINGS.

Location: Chesterfield County. Postoffice, Richmond.

No accommodations for the entertainment of guests exist, but the water has an extensive sale, both in its natural condition, and carbonated, in the principal eastern cities. It is highly prized as an eliminant of uric acid in the cure of gout and rheumatism.

The following analysis, made in this laboratory, shows the composition of the water:

Class: *Light carbonated. Lithic.*

One United States gallon of 231 cubic inches contains:

Magnesium bi-carbonate	0.14813	grains.
Calcium bi-carbonate	0.11839	"
Manganese bi-carbonate	0.00420	"
Iron (ferrous) bi-carbonate	0.02040	"
Calcium sulphate	0.10031	"
Potassium sulphate	0.16154	"
Sodium sulphate	0.11314	"
Lithium chloride	0.00385	"
Sodium chloride	0.34116	"
Sodium bromide	trace	"
Sodium iodide	0.00021	"
Sodium arsenate	0.00723	"
Sodium phosphate	0.00349	"
Silicic acid	0.60067	"
Alumina	0.01983	"
Total mineral matter	1.64256	"
Carbon dioxide free	12.49	cubic inches.

TALLEY'S SPRINGS.

Location: Mecklenburg County. Postoffice, Palmers Springs. The springs are eight miles distant from the Atlantic & Danville Railway and eleven miles from the Seaboard Air Line Railway.

These springs have not been developed, but have established a strong local reputation for curative properties. No complete analysis has been made, but the waters are said to be strong in sulphur and iron, and to show the presence of lithia. They are situated in a very attractive valley, having many desirable features for the location of a good summer resort.

VIRGINIA HOT SPRINGS.

Location: Bath County. Postoffice, Hot Springs. Access by Chesapeake & Ohio Railway to Covington, and by the Hot Springs branch of the Chesapeake & Ohio Railway to Hot Springs.

Through sleeping cars are run to the springs during the principal seasons, March to June and August to November, so that invalids can reach the springs without change.

This magnificent resort merits particular attention on account of the variety and value of its mineral waters, the exquisite beauty of its surroundings and the elaborate and extensive development of the property.

It is located at the altitude of 2,300 feet in Warm Springs Valley, with the lofty Appalachian Mountains surrounding it on all sides. As the result of this sheltered situation, the climate is mild and equable in the early and late months and delightful during the rest of the year.

The mean monthly temperature for June, July and August is 68.5 degrees Far. and the highest temperature observed during a number of years was 87 degrees Far.

The scenery of the region could not be surpassed. The valley, about two miles in width, stretches for about twelve miles between lofty and imposing mountains, from the crests of which

a panorama of mountain ranges and beautiful valleys, stretches to the horizon.

Numerous rugged and picturesque passes penetrate the mountains, through which the streams formed by the springs make their way in a succession of rocky falls and cascades, narrow chasms and deep gorges, presenting unending vistas of beauty.

The accommodations are of the finest character, consisting of two new hotels, the "Homestead" and the "Virginia," and ten modern cottages, supplied with every convenience and comfort. The bath-house, a fine stone and brick structure, built in the colonial style of architecture, cost over \$100,000, and is fitted up with every variety of bath and bathing requisite, including a fine swimming pool.

Among the many attractions are a finely laid out golf course, splendid boulevards and driving roads, and abundant hunting and fishing.

The various springs on this property have long been known and frequented for their curative properties, and are considered by high authorities to be equal to the best waters of a similar character, of the European spas.

Numerous springs, both hot and cold occur, most of which have been analyzed by various chemists. Within the past few years, however, complete analyses of all the important springs, have been made in this laboratory and these analyses are quoted here.

The thermal springs may be separated into two groups:

a. Those giving off sulphureted hydrogen in noticeable quantities.

b. Those in which no perceptible amount of that gas is given off.

Of the first group, the two springs are known as the "Hot Sulphur" and the "Brick." The former yields 54,000, and the lat-

ter 10,000 gallons of water per day, at a temperature being 99.4 degrees Far., practically identical in composition.

The following analysis is that of the "Hot Sulphur" spring:

Class: *Alkaline-saline-calcic. Sulphureted.*

One United States gallon of 231 cubic inches contains:

Magnesium carbonate	3.25239	grains.
Calcium carbonate	16.91222	"
Strontium carbonate .....	.04922	"
Barium carbonate .....	.01312	"
Iron (ferrous) carbonate .....	.01014	"
Manganous carbonate .....	.05124	"
Magnesium sulphate	5.53263	"
Calcium sulphate	4.04494	"
Potassium sulphate	1.51743	"
Sodium sulphate	1.01126	"
Sodium hyposulphite .....	.37440	"
Sodium sulphide .....	.27818	"
Sodium chloride .....	.58257	"
Sodium iodide .....	.00015	"
Calcium flouride .....	.08631	"
Lithium chloride .....	.08339	"
Alumina .....	.11546	"
Silica .....	.15979	"
	<hr/>	
Carbon dioxide combined	42.92826	"
	8.85342	"
	<hr/>	
	42.92846	"
Carbon dioxide free	20.55	cubic inches.
Hydrogen sulphide .....	.25	" "

Much gas is evolved from this spring, of the following composition:

Carbon dioxide	11.25	per cent.
Hydrogen sulphide .....	.75	" "
Nitrogen	83.75	" "
Oxygen	4.25	" "

Group B, includes five springs named respectively, the "Magnesia" spring, the "Boiler" spring, the "Octagon" spring, the "Spout" spring, the 102 Degree Spring, and the composition of the three waters first named is shown in the following table:

One United States gallon of 231 cubic inches contains:

	"Magnesia"	"Boiler"	"Octagon"
	Grains.	Grains.	Grains.
Magnesium carbonate ...	2.47559	2.70246	2.29371
Calcium carbonate	17.10467	18.63202	11.48264
Strontium carbonate ...	.04782	.05598	.05483
Barium carbonate .....	.01222	.01983	.01167
Iron (ferrous) carbonate	.25351	.03382	.25142
Manganous carbonate ..	.21974	.01808	.19367
Magnesium sulphate	6.49488	6.04233	7.42896
Calcium sulphate	1.61133	1.82477	1.50504
Potassium sulphate .....	.94149	1.45733	.79102
Sodium sulphate .....	.43852	.18981	.46318
Sodium hypo-sulphite..	.11955	.23735	.11434
Sodium sulphide .....	.21053		
Sodium chloride .....	.65261	.58057	.51101
Sodium iodide .....	.00015	.00026	.00013
Calcium fluoride .....	.07348	.07930	.05542
Lithium chloride .....	.03557	.07051	.03033
Alumina .....	.05832	.07115	.07000
Silica	1.27716	1.22468	1.60421
	31.81661	33.45078	26.87158
Carbon dioxide combined	8.81068	9.64811	7.43188
	40.62729	43.09889	34.30346
	cubic in.	cubic in.	cubic in.
Carbon dioxide free ..	20.6	24.6	22.14
Hydrogen sulphide....		.10	.16

Composition of Gases Evolved:

	per cent.	per cent.	per cent.
Carbon dioxide	10.25	9.10	10.30
Nitrogen	87.75	90.80	89.70
Hydrogen sulphide ..	trace	.10	trace
Temperature of the water	98.2 deg. F.	105.4 deg. F.	99.7 deg. F.
Flow per 24 hours.....	4,900 gal.	130,000 gal.	96,000 gal.

The water of the "Magnesia" spring is highly valued in the treatment of gout, rheumatism and disorders of the digestive organs and liver, and has been extensively used in the treatment of these diseases for more than a century.

The "Boiler" spring water is conveyed, with its natural heat retained, through protected pipes to the bath-house, and the resident physicians have great faith in its internal and external use.

The chief cold mineral springs in the immediate neighbor-

hood of the hotels are four in number and are known as the "Soda" spring "Lithia" spring, "Homestead" spring and "Cold Magnesia" spring.

The following table gives the composition of the first three named:

	"Soda"	"Lithia"	"Homestead"
	Grains.	Grains.	Grains.
Magnesium carbonate ...	.79954	.80712	4.16391
Calcium carbonate	15.82167	15.92781	9.83649
Strontium carbonate ....	.01166	.01283	.02994
Barium carbonate .....	.00641	.00758	trace
Iron (ferrous) carbonate	.00338	.00094	.08456
Manganous carbonate ...	.00012	.00012	
Zinc, lead, copper carbonate		trace	
Magnesium sulphate	5.72508	6.10006	.61701
Potassium sulphate	1.00307	1.03458	.74530
Calcium sulphate			2.77594
Sodium sulphate .....	.25893	.26185	.08689
Sodium chloride .....	.58026	.59776	.76572
Sodium iodide .....	.00537	.00560	.00082
Sodium bromide .....	.00437	.00449	
Sodium phosphate .....	.00268	.00309	.01341
Lithium chloride .....	.05015	.05138	.06094
Rubidium chloride		trace	
Calcium fluoride .....	.00291	.00297	trace
Alumina .....	.02916	.00350	.12829
Silica	1.16053	1.18269	.67066
	<u>25.46529</u>	<u>26.00450</u>	<u>19.97988</u>
Carbon dioxide combined	<u>7.38014</u>	<u>7.43088</u>	<u>3.66179</u>
	32.84543	33.43518	23.64179
	cubic in.	cubic in.	cubic in.
Carbon dioxide gas free	7.43	7.66	7.9

A valuable alum spring is located on the property about three and a half miles down Hot Springs Creek, having its source in the alum shales found in that neighborhood.

The following analysis shows its composition:

One United States gallon of 231 cubic inches contains:

Magnesium sulphate	4.40525	grains.
Calcium sulphate	13.20472	"
Strontium sulphate .....	.37557	"
Iron (ferrous) sulphate	4.68821	"
Manganous sulphate .....	.02099	"
Aluminium sulphate	12.56003	"
Potassium sulphate .....	.30500	"
Sodium sulphate .....	.33008	"
Lithium sulphate .....	.07989	"
Sodium chloride .....	.34116	"
Sodium iodide .....	.00017	"
Calcium fluoride .....	.01283	"
Silica .....	.16912	"
Sulphuric acid free	2.53683	"
	<hr/>	
	39.02985	"
Carbon dioxide gas, free	28.8	cubic inches.

WARM SPRINGS.

Location: Bath County. Postoffice, Warm Springs. Access by Chesapeake & Ohio Railway to Hot Springs, and by stage over a handsome boulevard to the springs, five miles distant.

This charming resort, famous during several generations for its hospitality and comfort, is picturesquely located in the northern part of Warm Springs Valley. The property embraces the entire width of the Valley including the mountain crests on either side—in all about 1,800 acres of land.

The fine hotel and cottages are beautifully situated in an extensive lawn, and are supplied with every requisite, convenience and comfort. The bathing pools are unique. The ladies' bath is a circular pool, 150 feet in circumference, holding 60,000 gallons of water, which is supplied by numerous springs emerging all over the bottom of the bath. Myriads of bubbles of gas constantly given off keep the water agitated and impart to it a delightful bouyancy. The gentlemen's pool is an octagon 40 feet in diameter with a capacity of 43,000 gallons of water, the temperature of which is constantly 96.3 degrees Far.

The combined flow from the springs, which constitutes the Warm Springs Creek is estimated to be 1,728,000 gallons in twenty-four hours.

In composition all the waters are practically identical, and the following analysis of the drinking spring, shows their character:

Class: *Sulphated-saline. Calicic. Sulphureted.*

One United States gallon of 231 cubic inches contains:

Calcium carbonate	11.69859	grains.
Strontium carbonate .....	.01283	"
Barium carbonate .....	.00612	"
Iron (ferrous) carbonate .....	.28576	"
Magnesium sulphate	7.73297	"
Calcium sulphate	6.99233	"
Potassium sulphate .....	.93950	"
Sodium sulphate .....	.34058	"
Sodium hyposulphite .....	.39715	"
Sodium sulphide .....	.46538	"
Sodium chloride .....	.42572	"
Sodium iodide .....	.00012	"
Lithium chloride .....	.08013	"
Calcium fluoride .....	.00542	"
Alumina .....	.05015	"
Silicic acid	1.59015	"
	<hr/>	
	31.02290	"
Carbon dioxide combined	5.00042	"
	<hr/>	
	36.02332	"

Gases in Solution:

Carbon dioxide free	4.025	cubic inches.
Hydrogen sulphide free .....	.19	" "
Temperature, 96.3 degrees Far.		

WASHINGTON SPRINGS.

Location: Washington County. Postoffice, Glade Springs. Access by Norfolk & Western Railway to Glade Springs, thence by private conveyance to the springs, two miles distant.

The springs are located at an altitude of 2,250 feet above sea-level, amid beautiful and picturesque surroundings. The accommodations consist of a good hotel fully equipped with all modern conveniences and requisites for comfort and pleasure.

There are seven springs with a combined hourly flow of about 30 gallons. The following analyses, by Mr. W. H. Seamon, give the composition of two of the springs:

Class: *Alkaline-calcic. Sulphureted.*

Sulphur Springs.

One United States gallon of 231 cubic inches contains:

Iron carbonate	0.52	grains.
Calcium carbonate	2.79	"
Potassium carbonate	0.11	"
Sodium carbonate	0.29	"
Calcium sulphate	6.47	"
Strontium sulphate		trace
Calcium phosphate	0.14	"
Sodium chloride	0.09	"
Arsenic chloride		trace
Hydrogen sulphide		present
Total	10.41	"

Class: *Alkaline-chalybeate-calcic.*

One United States gallon of 231 cubic inches contains:

Calcium sulphate	0.10	grains.
Magnesium sulphate	4.04	"
Strontium sulphate	0.38	"
Sodium sulphate	3.97	"
Aluminium sulphate		trace
Iron carbonate	1.95	"
Magnesium carbonate		trace
Calcium carbonate	13.66	"
Sodium chloride	0.34	"
Potassium chloride	0.24	"
Phosphoric acid		traces
Silica	2.07	"
Organic matter	1.03	"
	27.78	"

These waters are highly prized for their beneficial effect in the treatment of diseases resulting from anaemia or general debility.

YELLOW SULPHUR SPRINGS.

Location: Montgomery County. Postoffice, Yellow Sulphur Springs. Access by Norfolk & Western Railway to Christiansburg, thence by stage to the springs, three and one-half miles distant.

This popular resort situated on the summit of the Alle-

ghanies, at an elevation of 2,000 feet, is one of the most attractive of the Virginia Mountain Springs. The hotel, a fine modern structure, equipped with all recent improvements, stands in extensive grounds, shaded with virgin trees, and is delightfully cool in the warmest weather.

The spring yields 180 gallons of water per hour, the composition of which is shown by the following analysis, by Prof. William Gilham:

Class: *Sulphated-saline. Calcic.*

One United States gallon of 231 cubic inches contains:

Calcium carbonate	8.64	grains.
Magnesium carbonate	1.38	"
Iron carbonate .....	.62	"
Calcium sulphate	63.30	"
Magnesium sulphate	21.10	"
Aluminium sulphate	3.18	"
Potassium sulphate .....	.10	"
Sodium sulphate .....	.75	"
Iron Protoxide	trace	"
Calcium phosphate .....	.01	"
Magnesium phosphate	trace	"
Potassium chloride .....	.10	"
Sodium chloride .....	.07	"
Organic matter	3.73	"
	<hr/>	
	102.98	"
Carbonic acid	4.68	"
	<hr/>	
	107.66	"

This water is highly recommended for a number of diseases. In nervous affections it possesses strong sedative properties, and its tonic influence in cases of general debility is well marked. It is also used with good results in the treatment of chronic catarrh of the stomach, and intestines, and in certain female disorders, particularly aménorrhœa and leucorrhœa.

Used externally, good results are produced in certain skin diseases.

WOLF TRAP LITHIA SPRING.

Location: Wolf Trap Station, on Southern Railway.
Halifax County.

This water is obtained from a well seventy-four and one-half feet deep, and has an extensive sale.

Its composition is shown by the following analysis, by Prof. M. B. Hardin:

Class: *Alkaline-carbonated. Lithic.*

One United States gallon of 231 cubic inches contains:

Sodium carbonate	0.24027	grains.
Lithium carbonate	0.01726	"
Ammonium carbonate	0.00128	"
Calcium carbonate	7.41222	"
Magnesium carbonate	5.09221	"
Strontium carbonate	0.38489	"
Iron carbonate	0.06007	"
Manganese carbonate	0.0134	"
Copper carbonate	0.001234	"
Sodium chloride	2.62956	"
Sodium bromide	0.00630	"
Sodium iodide	0.00065	"
Sodium nitrate	2.62548	"
Potassium sulphate	0.06356	"
Sodium sulphate	0.06007	"
Aluminium phosphate	0.04432	"
Silica	2.01780	"
Barium carbonate	trace	
Zinc carbonate	trace	
Magnesium borate	trace	
Calcium fluoride	trace	
Titanic oxide	trace	
Organic matter (yielding ammonia)	trace	
	20.66836	"

Carbon dioxide associated with the above carbonates in the so-called bi-carbonates	6.06682	"
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Gases:

Carbon dioxide, free	12.38	cubic inches.
Nitrogen	3.60	"
Oxygen	1.70	"
	17.68	"

TOP
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