PRECIOUS STONES.

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BY GEORGE FREDERICK KUNZ.

The statistics of this report are divided into two sections: first, the discoveries and finds of precious and semiprecious stones in the United States, and the mineral specimens sold for museums and private collections or for bric-a-brac purposes; second, the diamond-cutting industry.

DISCOVERIES OF PRECIOUS STONES.

Up to the present time there has been very little mining for precious or semiprecious stones in the United States, and then only at irregular periods. It has been carried on during the past few years at Paris, Maine; near Los Cerrillos, New Mexico; in Alexander county, North Carolina, from 1881 until 1888, and on the Missouri river, near Helena, Montana, since the beginning of 1890. True beryls and garnets have been frequently found as a by-product in the mining of mica, especially in Virginia and North Carolina. Some gems, such as the chlorastrolites, thomsonites, and agates of Lake Superior, are gathered on beaches, where they have fallen from rock which has gradually disintegrated by weathering and wave action. It is the intention here to show only the recent discoveries, and especially those in 1889. A more extended account of the occurrence of precious stones is found in "Gems and precious stones of North America", by the same author.

DIAMOND.

A very limited number of diamonds have been found in the United States. They are met with in well-defined districts of California, North Carolina, Georgia, and recently in Wisconsin, but up to the present time the discoveries have been rare and purely accidental. Their occurrence is chiefly confined to a belt of country lying along the east flank of the southern Alleghenies from Virginia to Georgia, of Archæan and Cambrian age, and another along the western bases of the Sierra Nevada and the Cascade ranges, in northern California and southern Oregon. In both districts the diamonds are found in loose material, the débris of the crystalline rocks of the adjacent mountains, among deposits of gravel and earth, associated with garnet, zircon, iron sand, monazite, anatase, and particularly gold. Hitherto they have never been obtained in quantities to justify an attempt at diamond mining, although some specimens have been of local interest and of market value.

The rocks in the diamond-bearing localities in the southern states are mainly granitic, and the mode of occurrence approaches that of the diamond fields of Brazil and parts of India, but differs entirely from that of South Africa. The similarity of the associated minerals is due to the fact that these loose deposits in both regions are merely the débris of the crystalline rocks of the adjacent mountains.

In both these regions, as well as on Plum creek, Pierce county, Wisconsin, the diamonds have been found in the search for gold; in the south and in California, in placer mining, in the flumes and sluices of the hydraulic workings, and in California frequently in the batteries of the stamps. They have often been overlooked, unrecognized, or destroyed by rude methods of testing. The entire finds may be summed up as follows: the octahedral diamond, weighing 24.75 carats, at Manchester, opposite Richmond, Virginia, in 1854, which was cut into a gem weighing 11.34 carats; about 100 diamonds, weighing from 0.25 carat to 5 carats, in the North Carolina and Georgia localities; about 200 diamonds, from 0.5 carat to 4 carats each, in California; 2 diamonds in Indiana; 7 small ones, none weighing as much as 1 carat, at Plum creek, Pierce county, Wisconsin; and a few isolated diamonds reported from Idaho, Arizona, Arkansas, and Adair county, Kentucky.

SAPPHIRE.

The corundum gems, sapphire, ruby, oriental emerald, etc., have been found in only 2 states, North Carolina and Montana, and then never in fine gems.

At Corundum Hill, Macon county, North Carolina, about 100 gems have been found during the last 20 years, some of good blue color and some of good red color, but none exceeding $100 in value, and none within the past 10

years. One crystal of oriental emerald (green corundum) that has not been cut would furnish at least $1,000 worth of cut gems. Brown asteroid corundum star or asteria sapphire is also found at this locality.

In Montana sapphires have been found on the bars for 6 miles along the Missouri river, at what are known as Eldorado, Spokane, French, and Ruby bars. Spokane bar is about the central point, and is about 12 miles west of Helena. The deposits may extend farther up and down the river. No systematic attempt has been made to work these bars for sapphire, although they were pretty thoroughly sluiced for gold as early as 1865. Since then the sapphires have been sent east occasionally, but not until recently have they received much recognition, owing to the high price of cutting sapphire gems and the small demand then existing for stones other than those of a positive color, such as true ruby red or sapphire blue. About 1880 some $2,000 worth were sold annually.

In 1889 an area of about 4,000 acres was secured by a company that contemplated working Eldorado bar, Ruby bar, and others on the Missouri river. The property has been prospected by mining engineers, who estimate that Eldorado bar will yield some 2,000 ounces of sapphires to the acre, but only a part of these may be of such quality as to warrant cutting. The stones found embrace a great variety of the lighter shades of red, yellow, blue, and green. The latter color is found quite pronounced, being rather a blue green than an emerald green, sometimes slightly asteriated, and generally dichroitic; that is, blue in one direction and red in the other. Nearly all the stones when finely cut have an apparent metallic luster, which is strikingly peculiar to those from this locality. No true red rubies nor any true blue sapphires have been found. Frequently the blues and greens assume a red tint by artificial light. The sapphires are principally found in a layer of auriferous glacial gravel a few inches in thickness, which lies immediately on a slaty bed rock.

Among the associated minerals observed were white topaz in brilliant crystals, garnets in rounded grains, occasionally as large as a pea and rich ruby red in color (often mistaken for and called rubies), cyanite, chalcedony, cassiterite, and limonite in rolled pebbles.

Fancy stones of from 4 to 6 carats each are frequently met with, and a fine one of 9 carats was found, of a rich greenish-blue color. The value of gems cut from the material found in this district amounted at one time to over $2,000 a year. In 1889 a dike of eruptive rock was discovered cutting the slaty rock at Ruby bar, on which rests the glacial gold gravel. In this eruptive rock there were found crystals of sapphire, pyrope garnet, and sanidine feldspar; so that there can be little doubt that all the sapphires that have been found along the Missouri river have come from the breaking down of a rock similar to this, and it is very evident that some outcroppings have been eroded by glacial action north of all the bars. The precise locality, however, is a question. They can not have come from the eruptive rock deposit at Ruby bar, because this locality is 6 miles south of Eldorado bar, where a number of sapphires have been found, but rather from some dikes, now worn away or covered over, north of Eldorado bar.

CHRYSOBERYL.

Chrysoberyl has been obtained in large crystals, some weighing several pounds, but opaque and of no gem value, at Stoneham, Norway, and other localities in Maine; also at Haddam, Connecticut, and Greenfield, near Saratoga, New York. The alexandrite variety has not been observed.

SPINEL.

A few smoky-blue and dark velvety-green gems were formerly obtained near Hamburg, Sussex county, New Jersey, and occasionally in the limestone with sapphire and ruby, not transparent, from Amity, New York, to Andover, New Jersey, a distance of 30 miles. This occurrence in limestone is almost identical with the occurrence of the oriental or true ruby and spinel at the famous mines in the valley of the Mogok, near Mandalay, Burmah. Immense black opaque crystals of spinel, some 4 inches in diameter, were formerly obtained in great quantities from a locality near Monroe, New York.

BERYL.

Of the beryl gems (emerald, aquamarine, and golden beryl) the emerald has been mined to some extent at Stony Point, in Alexander county, North Carolina, and has also been obtained at 2 other places in the county. Nearly everything found has come from the Emerald and Hiddenite mines, where, during the past decade, emeralds have been mined and cut into gems to the value of $1,000, and also sold as mineralogical specimens to the value of $3,000; lithia emerald, or hiddenite (which is mineralogically a variety of spodumene), to be cut into gems, $8,500, and for mineralogical specimens, $1,500; rutile, cut and sold as gems, $150, and as specimens, $50; and beryl, cut and sold as gems, $50.

At an altitude of 14,000 feet, on Mount Antero, Colorado, during the last 3 years material has been found which has afforded $1,000 worth of cut beryls. At Stoneham, Maine, fine aquamarine has been found, which was cut into about $1,500 worth of gems.

At New Milford, Connecticut, a property was extensively worked from October, 1885, to May, 1886, for mica and beryl. The beryls were yellow, green, blue, and white in color, the former being sold under the name of "golden beryl". No work has been done at the mine since then. In 1886 and 1887 there were about 4,000 stones cut and sold for some $15,000, the cutting of which cost about $3,000.

TOPAZ.

Small brilliant crystals have been found at Thomas mountain, Sevier county, Utah; in northern Colorado, in wine-colored crystals, at Devils Head mountain, 30 miles from Pikes Peak, and on Cheyenne mountain, near Pikes Peak, in splendid crystals, colored light blue, light green, and white. A single crystal weighed over 1 pound. Several thousand dollars' worth were sold as specimens, and fully 3,000 have been cut. 2 exceptional gems weighed 125 and 193 carats, respectively. At Stoneham, Maine, large crystals with little transparency have been found. At Bald mountain, North Chatham, New Hampshire, topaz occurs with phenacite in fine crystals. Fully $1,000 worth have been found in 1 year.

PHENACITE.

In fine transparent crystals, phenacite has been found associated with topaz at 3 localities near Pikes Peak, Colorado, also at Mount Antero, Colorado, and Bald mountain, New Hampshire. Many of the crystals found would do to cut into gems, but its value is almost purely due to its mineralogical interest.

TOURMALINE.

Tourmaline has been found for the past 60 years at Mount Mica, Paris, Maine, in magnificent crystals, which have often furnished gems rivaling any ever found. Fully $50,000 worth of gems and crystals have been found here. Fine crystals have been found at Auburn and Hebron, Maine.

SPODUMENE, OR LITHIA EMERALD (HIDDENITE).

Spodumene, or lithia emerald (hiddenite), is a transparent variety of spodumene, varying from yellow green to a deep, brilliant, almost emerald green, with yellowish reflections. It is found in Alexander county, North Carolina (see Beryl). About $8,500 worth of material has been cut into gems or sold as specimens during the past 10 years.

GARNET.

The finest known garnets and nearly all the peridots found in the United States are obtained in the Navajo nation, in the northwestern part of New Mexico and the northeastern part of Arizona, where they are collected from ant-hills and scorpion nests by Indians and by the soldiers stationed at the adjacent forts. Generally these gems are traded for stores to the Indians at Gallup, Fort Defiance, Fort Wingate, etc., who in turn send them to large cities in the east in parcels weighing from 0.5 ounce to 30 or 40 pounds each. These garnets, which are locally known as Arizona and New Mexico rubies, are the finest in the world, rivaling those from the Cape of Good Hope. Fine gems weighing from 2 to 3 carats each and upward when cut are not uncommon. The peridots found associated with garnets are generally 4 or 5 times as large, and from their pitted and irregular appearance have been called "Job's tears". They can be cut into gems weighing 3 or 4 carats each, but do not approach those from the Levant either in size or color. These garnets present a large variety of tints, of rich red, claret, almandine, and even yellow essonite-colored stones. They are often believed by the finders to be spinels or rubies and are frequently sold as "Arizona", "Colorado", or "New Mexican" rubies.

Although the garnets found in the South African diamond mines, the so-called "Cape rubies", are of larger size than those of Arizona and New Mexico, which are rarely over 2 or 3 carats, and perhaps equal to them in color by daylight, the latter are much superior by artificial light, only the clear, blood-red hue being visible, while in the "Cape rubies" the dark color still remains unchanged. They are extensively used as gems, the annual sales amounting to $5,000 worth of cut stones. A few remarkably fine ones have brought $50 each, though stones of equal quality have frequently sold for much less. These garnets have never been found in place by any geologist or any surveyor, but it is evident from the associated minerals that they have weathered out of a peridotite rock. They are from one-eighth to one-fourth of an inch in diameter, rarely over one-third, and but few have been seen measuring two-thirds of an inch. In form they are generally round and pitted, like large currants, but often with fractured edges.

Pyrope garnets of good color, that have furnished gems, have been found in the sands of the gold washings of Burke, McDowell, and Alexander counties, North Carolina. In the peridotite and in the débris resulting from its weathering, at Isons Mills, Elliott county, Kentucky, are found deep ruby-red grains of pyrope garnet in considerable quantity.

In Burke county, North Carolina, especially near Warlick, large quantities of purple garnet (almandite) have been found in crystals weighing up to 20 pounds each, and many tons have been ground into emery. They are often fine enough to cut into watch jewels and into small dishes.

At Ruby mountain, 3 miles from Salida, Chaffee county, Colorado, is a remarkable deposit of opaque and translucent almandite garnet crystals, in a bed of soft green chlorite, out of which they fall when the rock is broken. These crystals vary in weight from 1 ounce to 12 pounds. 2 very perfect crystals, weighing, respectively, 14 and

14.5 pounds, were simple dodecahedrons in form, and altered to chlorite superficially, often to the depth of a tenth of an inch. Internally they are very compact and often show 2 or 3 distinct zones of color, but not being transparent they are not of gem value. At least 5 tons of these crystals have been sold to collectors and tourists for specimens, paper weights, ornaments, etc. They are compact enough to make them valuable for watch jewels or for ornamental purposes.

Large quantities of purple almandite garnet, in the form of rolled fractured pieces, have been found along the Columbia river, in the states of Washington and Oregon.

On the Stickeen river, near Fort Wrangell, Alaska, are deposits of mica containing perfect crystals of almandite garnet ranging in size from 0.5 inch to 2 inches in diameter. These are mined by the ton and sold to tourists or sent to the United States for cabinet specimens.

Essonite (cinnamon garnet, cinnamon stone, or the hyacinth of the jeweler) occurs sparingly in good quality in Phippsburg, Oxford county, Maine, and Warren, New Hampshire. Beautiful transparent flattened crystals are found between plates of mica at Avondale quarry, Pennsylvania, and near Bakersville, North Carolina. At Amelia Court House, Virginia, a large quantity of spessartite garnet, a variety of essonite, in which part of the alumina is replaced by manganous oxide, has been found in masses several inches across, and of dark brown, dark red, and honey-yellow colors. These are the finest specimens of this variety of garnet ever found, and have yielded gems of from 1 to 100 carats in weight, almost rivaling the essonite from Ceylon.

TURQUOISE.

This mineral, which was worked by the Aztecs before the advent of the Spaniards, and since then by the Pueblo Indians, and largely used by them for ornament and as an article of exchange, is now systematically mined near Los Cerrillos, New Mexico. Its color is blue, and its hardness is fully equal to that of the Persian, or slightly greater, owing to impurities. All found previous to this year lacked that softness of color belonging to the Persian turquoise, but the recent find compares favorably.

From time immemorial this material has been rudely mined by the Indians. Their method is to pour cold water on the rocks after previously heating them by fires built against them. This process generally deteriorates the color of the stone to some extent, tending to change it to a green. The Pueblos barter turquoise with the Navajo, Apache, Zuñi, San Felipe, and other New Mexican tribes for their baskets, blankets, silver ornaments, and ponies, to the value of over $3,000 annually.

In 1870 an unsuccessful attempt was made to work an ancient locality at Los Cerrillos, the scene of the disaster which led to the insurrection 3 centuries before. It was believed that the rock which contained the turquoise would yield enough gold to pay for the working and thus the turquoise would be the profit. All the stones found at that time were too green to have much commercial value. During the past year an ancient mine 7 miles from the old workings, has been reopened and a 75-foot shaft has been sunk. The turquoise is good in color, better than any heretofore found; and although none as fine as the best Persian has been obtained, the yield for the entire year is said to have been sold for over $10,000. Turquoise has been observed in Fresno county, California; Humboldt county, Nevada: Saguache county, Colorado; at 3 localities in Arizona, and at a new locality in Grant county, New Mexico.

QUARTZ.

During the year 1887 about half a ton of rock crystal, in pieces weighing from a few pounds up to 100 pounds each, was found in decomposing granite in Chestnut Hill township, Ashe county, North Carolina. One mass of 20.5 pounds was absolutely pellucid, and more or less of the material was used for art purposes. This lot of crystal was valued at $1,000.

A number of quartz crystals almost entirely pellucid, weighing up to 50 pounds each, have been found near Placerville, California.

In Arkansas, especially in Garland and Montgomery counties, rock crystals occur lining cavities of variable size, and in one instance 30 tons of crystals were found in a single cavity. These crystals are mined by the farmers in their spare time and sold in the streets of Hot Springs, their value amounting to some $10,000 annually. Several thousand dollars' worth are cut from quartz into charms and faceted stones, although 10 times that amount of paste or imitation diamonds are sold as Arkansas crystals.

Rose quartz is found in the granitic veins of Oxford county, Maine, and in 1887, 1888, and 1889 probably $500 worth of this material was procured and worked into small spheres, dishes, charms, and other ornamental objects.

AMETHYST.

Light-colored crystals are found in great quantity at Stow, Maine. Occasionally a superb gem is also found in magnificent purple crystals in Upper Providence township, Delaware county, Pennsylvania; at many localities in Colorado, and the Yellowstone Park, associated with agate and agatized wood, generally of little value, however.

GOLD QUARTZ.

Since the discovery of gold in California, compact gold quartz has been extensively used in the manufacture of jewelry, at one time to the amount of $100,000 per annum. At present, however, the demand has so much decreased that only from $5,000 to $10,000 worth is annually used for this purpose.

In addition to the mineral used for cabinet specimens, etc., there is a great demand for making clocks, inkstands, and other objects.

To be of value for jewelry and souvenirs, the quartz must be clear, compact, white, containing veins, streaks, or spots of fine gold. The white gold quartz of California is mainly supplied from the counties of Butte, Calaveras, Eldorado, Mariposa, Nevada, Placer, Sierra, Tuolumne, and Yuba. The mines of California, Oregon, and Montana have furnished very fine specimens. The gold found in California quartz is worth about $16.50 an ounce, but jewelers willingly give from $20 to $30 for each ounce of gold contained in material that they can use. The price of specimens is governed by their beauty, varying from $3 to $40 per ounce of quartz.

AGATE.

Agate, chalcedony, carnelian, sard, and other varieties of the agate group are abundant at many places in North America. At Agate bay, Lake Superior, large numbers of small banded agates, often of a rich red color are found. Often these natural pebbles are polished all over, then drilled at one end, and sold to tourists as charms, or they are placed in bottles of water to show the markings to the best advantage, neatly arranged according to color and size, and sold as mementoes. Many fine agates, some of great beauty, are found in Colorado and elsewhere through the Rocky mountains, but only a few are polished, because the agates from Brazil and Uruguay can be cut in Germany and sold at much lower rates, so that nearly all the polished agates sold in America are from the German market.

Moss agate is found in great quantity in Wyoming, Colorado, Utah, and Montana. It was formerly used in jewelry by the ton, as much as $20,000 worth being sold annually. When this stone was fashionable, as much as $5 to $10 was paid for a single stone; those found in brooks, so-called "river agates", were preferred. At present not over $1,000 worth is sold, and this only in tourists' jewelry.

The well-known agatized and jasperized wood of Arizona is so much richer in color than that obtained from any other known locality that, since the problem of cutting and polishing the large sections used for table tops and other ornamental purposes was solved, fully $50,000 worth of the rough material has been gathered, and over $100,000 worth of it has been cut and polished. Single tree-sections 40 inches in diameter, columns drilled out of the solid trunks 10 to 12 inches in diameter, and other difficult pieces have been cut and polished. This wood, which was a very prominent feature at the Paris Exposition, promises to become one of our richest ornamental materials. It is one of the most important of the ornamental stones—in fact, the richest ornamental stone of modern times.

Chalcedony park, which is the nearest of the 3 so-called forests in this formation on the Atlantic and the Pacific railroad, is about a mile square, and is inclosed by table-lands from 50 to 100 feet in height. Nearly all the agatized wood is on the flat plain below these table-lands and rests on layers of sandstone. The lower layer is chocolate-red, another white, another black, and another (a compact sandstone) gray; and on these rests a layer of white sandstone, in which originally was found all the wood at this locality. It is by the washing and weathering away of this formation that the tree trunks have rolled down to the level plain below. None of those lying below were ever in place there. None in the upper layer are in the upright position, nor were any of the roots visible; and, since none of the trees retain any of the original bark, it seems very probable that all this deposit was once the bed of an inland sea or lake.

OPAL.

Only at 2 localities in the United States has opal of gem value been observed. A single pebble of fire opal was found on the John Davies river, Oregon.

During the past year, near Whelan, southwest of Colfax, Washington, between the Cœur d'Alene and Nez Percés Indian reservations, almost on the Idaho and Washington lines, a brilliant fire opal and noble opal were found in the form of grains about the size of a pea, filling the cavities in an amygdaloid basalt rock. The quality of this opal is good and this may be a promising locality. Some of it is very fine, the value depending on the quantity found. It occurred more or less plentifully, as the last 4 feet of the rock contained cavities filled with precious opal. This opal occurs in a basalt in which most, if not all, of the feldspar and pyroxene, as well as the green mass, appear to be altered.

AMAZON STONE.

At the Crystal beds and other localities near Pike's Peak, Colorado, amazon stone (microcline) is found in large cavities in a coarse pegmatite granite with flesh-colored and white feldspars, as well as smoky quartz crystals, all often of huge size. Many thousand crystals of the most beautiful green color have been obtained here, some measuring from one-half an inch to over a foot in length, and of different shades of green, from the lightest and most delicate to a deep apple green. From the Pike's Peak locality 1 dealer sold over $8,000 worth as minerals. As high as

$200 was paid for a single specimen. Over $1,000 worth from this place are annually cut into tourists' jewelry. Tons of rich green cleavages were found at the Allen mica mines, Amelia Court House, Virginia, with beautiful albite moonstone resembling that from Ceylon in quality, transparency, and color, and forming gems 0.5 inch across, and opaque cleavages 4 inches square, showing a delicate blue chatoyancy.

Labrador spar is found in large quantities in Lewis and Essex counties, New York, occurring as bowlders in the drift all the way down to Long Island and New Jersey. A common variety, used for building purposes, is quarried at Keeseville, Lewis county, where the bowlders are so plentiful in the river that it has been named Opalescent river.

CHLORASTROLITE, THOMSONITE, ETC.

Chlorastrolite in pebbles is found principally on the inner and outer shores of Rock harbor, a harbor about 8 miles in length on the east end of Isle Royale, Lake Superior, where they occur from the size of a pin head to (rarely) the size of a pigeon's egg. When larger than a pea they frequently are very poor in form, or are hollow, in fact, and unfit for cutting into gems. They are collected in a desultory manner, and are sold by jewelers of Duluth, Petoskey, and other cities, principally to visitors. The annual sale ranges from $200 to $1,000.

Thomsonite and lintonite in pebbles occur with the chlorastrolites at Isle Royale, but finer stones are found on the beach at Grand Marais, Cook county, Minnesota. Like the chlorastrolites, they result from the weathering of the amygdaloid rock, in which they occur as small nodules, and in the same manner are sold by jewelers in the cities bordering on Lake Superior to the extent of $200 to $1,000 worth annually.

MALACHITE.

Malachite, although found in many localities in the United States, and sometimes abundant with ores of copper, has been found of beauty enough for use in the arts; and at the Copper Queen mine at Bisbee, Arizona, masses weighing 15 pounds and upward have been found, rivaling the Russian in quality, and which by piecing would furnish table tops.

At Morenci, Arizona, there has been found an interesting form of azurite and malachite in rounded stalagmites which, when cut across, have often from 2 to 6 layers of blue and green, forming a very pleasing combination, in concentric zones, both minerals admitting of a beautiful polish.

CORAL.

Fossil corals, consisting of carbonate of lime, often possess great structural beauty, are very compact, and susceptible of a high polish. These are very plentiful along the shores of Little Traverse bay, at Petoskey, Michigan, where water-worn pieces of various species of coral ranging from fragments the size of a small pebble to masses of 2 or 3 pounds are frequently found. The spaces or cells of these corals are entirely filled with carbonate of lime and, being very compact, they take a fine polish. In color they are of various shades of gray, and many of them exceedingly handsome. The lapidaries of the place cut and polish these corals, and at present probably $4,000 or $5,000 worth are annually sold by them, either polished on one side are in the form of seals, charms, cuff-buttons, paperweights, and other ornaments.

LODESTONE.

Lodestone, or native magnet, is the magnetic iron oxide. Although not now used as a gem, it was worn centuries ago for the power it was supposed to possess and for the charm it was presumed to give the wearer. Large quantities of it are found at Magnet cove, Arkansas, and it is estimated that several tons are sold annually to the southern negroes to be used by the voudoos, who employ it as a conjuring stone.

FLUORITE.

Fluorite, in the colored transparent varieties, is designated as false ruby, emerald, sapphire, topaz, amethyst, etc. 30 years ago many superb specimens of the green variety were taken from a vein of this mineral that ran out under Muscalonge lake, Saint Lawrence county, New York. In 1888 several tons of fine green crystals, some a foot square, were found at Macomb, in the same county. Large quantities of superb red, blue, and purple fluorite are found in Hardin county, Illinois, where thousands of tons are mined for industrial purposes.

PYRITE.

Pyrite, or sulphide of iron, is found in many localities in the United States. Crusts of small crystals are trimmed and cut into ovals, squares, and other shapes, and sold for mounting as scarf pins, lace pins, earrings, ring stones, etc. Fine single crystals are also sold for ornaments in Pennsylvania and Colorado. Several thousand dollars' worth are sold annually.

AMBER.

Amber has been sparingly observed at a number of localities in central and southern New Jersey, on the Magothy river, Maryland, and in North Carolina and Wyoming, but, up to the present, nowhere in the United States in sufficient quantity to warrant searching for it.

PRODUCTION OF PRECIOUS STONES, ORNAMENTAL MINERALS, ETC., IN 1889.

NAMES OF GEMS OR PRECIOUS STONES	Total value.	Value of stones before cutting.	Value of stones after cutting into gems for ornamental purposes.	Value of stones sold as specimens and curiosities, occasionally polished to beautify or show the structure.	NAMES OF GEMS OR PRECIOUS STONES.	Total value.	Value of stones before cutting.	Value of stones after cutting into gems for ornamental purposes.	Value of stones sold as specimens and curiosities, occasionally polished to beautify or show the structure.
Total	$188,807	.....	$107,645	$81,162	Chrysoprase	$200	$50	$200	.....
Sapphire	6,725	,600	6,725	.....	Agatized and jasperized wood	53,175	42,725	53,000	$175
Emerald	450	.....	300	150	Banded and moss jasper	630	.....	80	550
Aquamarine	747	225	597	150	Amazon stone	500	.....	.....	500
Phenacite	200	.....	.....	200	Pyrite	2,000	100	500	1,500
Topaz	400	100	200	200	Chlorastrolite	500	200	300	200
Turquoise	23,675	10,000	23,175	500	Thomsonite	400	100	200	200
Tourmaline	2,250	1,030	2,250	.....	Fluorite	500	.....	.....	500
Garnet	2,308	510	1,633	675	Fossil coral	700	100	200	500
Quartz	14,000	510	2,750	11,250	Azurite and malachite	2,037	1,000	.....	2,037
Amethyst	98	15	98	.....	Catlinite (pipestone)	5,000	.....	.....	5,000
Rose quartz	600	200	400	200	Zircon (*a*)	16,000	.....	.....	16,000
Smoky quartz	4,232	700	4,007	225	Gadolinite, fergusonite, etc. (*a*)	1,500	.....	.....	1,500
Gold quartz	9,000	6,000	9,000	.....	Monazite (*a*)	1,000	.....	.....	1,000
Rutilated quartz	30	2	30	.....	Spodumene (*a*)	200	.....	.....	200
Dumortierite in quartz	250	.....	.....	250	Wooden ornaments decorated with minerals (*b*)	15,500	.....	.....	15,500
Quartz coated with chalcedony	4,000	1,000	2,000	2,000	Miscellaneous minerals (*c*)	20,000	.....	.....	20,000

a Used to extract the rarer elements for chemical purposes. *b* Such as clocks, horseshoes, boxes, etc. *c* For cabinets, museums, etc.

PRECIOUS STONES AND ORNAMENTAL STONES AND MINERALS FOR CABINETS FOUND IN THE UNITED STATES IN 1889, BY STATES AND TERRITORIES.

STATES AND NAMES OF MINERALS.	Total value.	Value of stones before cutting.	Value after cutting into gems.	Value of specimens, curiosities, etc., occasionally polished to beautify and show structure.	STATES AND NAMES OF MINERALS.	Total value.	Value of stones before cutting.	Value after cutting into gems.	Value of specimens, curiosities, etc., occasionally polished to beautify and show structure.
Total	$188,807	.....	$107,645	$81,162	Maine—Continued:				
Arizona:					Spodumene	$200	.....	.....	$200
Garnet	100	.....	100	.....	Rose quartz specimens	400	$200	$400	.....
Agatized and jasperized wood	53,175	$42,725	53,000	175	Miscellaneous minerals	1,700	.....	.....	1,700
Azurite and malachite	2,037	1,000	.....	2,037	Michigan:				
Dumortierite in quartz	250	.....	.....	250	Fossil coral	700	100	200	500
Wulfenite, vanadinite, etc	1,450	.....	.....	1,450	Minnesota:				
Arkansas:					Catlinite ornaments	5,000	.....	.....	5,000
Quartz	12,700	500	2,700	10,000	Chlorastrolite	500	200	300	200
Wavellite	750	.....	.....	750	Thomsonite	400	100	200	200
California:					Montana:				
Gold quartz	9,000	6,000	9,000	.....	Sapphire	6,725	2,600	6,725	.....
Rose quartz	200	.....	.....	200	New Mexico:				
Chrysoprase	200	50	200	.....	Garnet	1,500	500	1,500	.....
Garnet	50	.....	.....	50	Turquoise	23,675	10,000	23,175	500
Miscellaneous minerals for ornaments.	5,000	.....	.....	5,000	New York:				
Colorado:					Quartz	1,300	10	50	1,250
Smoky quartz	4,200	700	4,000	200	Fluorite	500	.....	.....	500
Wood agate and wood jasper	4,000	1,000	2,000	2,000	North Carolina:				
Phenacite	200	.....	.....	200	Aquamarine	347	125	347	.....
Aquamarine	400	100	250	150	Emerald	450	.....	300	150
Garnet	625	.....	.....	625	Amethyst	98	15	98	.....
Topaz	400	100	200	200	Garnet	33	10	33	.....
Miscellaneous minerals	6,100	.....	.....	6,100	Rutilated quartz	30	2	30	.....
Mineral clocks, ornaments, etc.	15,500	.....	.....	15,500	Smoky quartz	32	.....	7	25
Amazon stone	500	.....	.....	500	Zircon for chemical uses	16,000	.....	.....	16,000
Pyrite	2,000	100	500	1,500	Monazite	1,000	.....	.....	1,000
Kansas:					Texas:				
Banded jasper	80	.....	80	.....	Gadolinite and fergusonite	1,500	.....	.....	1,500
Moss jasper	550	.....	.....	550	Utah:				
Maine:					Minerals	2,500	.....	.....	2,500
Tourmaline	2,250	1,030	2,250	.....	Virginia:				
					Quartz, pebbles, etc	2,500	.....	.....	2,500

LABOR EMPLOYED IN PRODUCING PRECIOUS STONES IN 1889.

STATES.	Number of men employed.	Average daily wages.	Average days employed.	Number of boys employed.	Average daily wages.	Average days employed.	Total expenditures.	Total wages.	Other expenditures.
Total	187	$2.50	253	112	$1.18	265	$204,117	$148,355	$55,762
California	9	3.17	258	.....	.....	.....	7,995	7,225	770
Colorado	10	3.58	170	.....	.....	.....	13,315	5,740	7,575
Illinois	49	1.51	307	1	0.75	185	24,804	23,880	924
Massachusetts	13	2.64	301	71	1.39	300	64,902	39,902	25,000
New Jersey	23	2.54	152	19	0.95	143	12,625	10,500	2,125
New York	48	3.14	257	15	0.67	268	41,895	40,640	1,255
Pennsylvania	5	4.15	178	3	0.62	225	4,843	3,668	1,175
Other states (a)	30	2.15	252	3	1.00	255	33,738	16,800	16,938

a The states here grouped embrace Missouri, Rhode Island, South Dakota, Virginia, and Wyoming.

THE DIAMOND-CUTTING INDUSTRY.

In New York there are 16 firms engaged in cutting and recutting diamonds, and in Massachusetts there are 3. Cutting has also been carried on at times in Pennsylvania and Illinois, but has been discontinued. In 1889, 7 of the New York firms ran on full time, but the others were unemployed, respectively, 14, 50, 61, 120, 125, and 240 days, owing to inability to obtain rough material at a price at which it could be advantageously cut. The firms fully employed were generally the larger ones, whose business consisted chiefly in repairing chipped or imperfectly cut stones or in recutting stones previously cut abroad, which, owing to the superior workmanship in command here, could be recut at a profit, or in recutting very valuable diamonds when it was desired, with the certainty that the work could be done under their own supervision, thus guarding against any possible loss by exchange for inferior stones.

It will be seen from the following table that the industry employed 236 persons, of whom 69 were under age, who received $148,114 in wages. Of the 19 establishments, 16 used steam power. The power is usually rented. Foot power is only used in 1 establishment. 3 of the firms are engaged in shaping black diamonds for mechanical purposes, for glasscutters and engravers, or for use in the manufacture of watch jewels.

The average weight of the material before and after cutting is also given in the table. The marked difference in the prices of diamonds, as shown, is due to variations in the weight and quality of the stones.

Beginning in the latter part of 1888, and through 1889, there was a marked increase in the price of rough diamonds, resulting in rapid advances of from 20 to 25 per cent at a time, amounting in all to an advance of from 80 to 100 per cent above the prices of the previous years.

DIAMOND-CUTTING INDUSTRY.

STATES.	Number of works.	Weight of material before cutting. (Carats.)	Weight after cutting into watch jewels and for mechanical uses. (Carats.)	Value after cutting into gems.	LABOR AND WAGES.						Total wages.	Value of machinery used in cutting.
					Number of men employed.	Average wages per day.	Average number of days employed.	Number of boys employed.	Average wages per day.	Average number of days employed.		
Total	19	54,344	25,005	$1,006,716	167	$3.53	234	69	$0.65	216	$148,114	$77,050
Massachusetts	3	4,100	1,580	41,000	11	4.10	300	4	1.17	300	14,934	3,000
New York	16	50,244	23,425	965,716	156	3.49	229	65	0.62	211	133,180	74,050

IMPORTS.

The diamonds used in this industry are all imported, for, as already stated, diamonds are only occasionally found in the United States. The following table gives the value of imported rough diamonds for a series of years:

VALUE OF IMPORTED ROUGH OR UNCUT DIAMONDS FROM 1873 TO 1889, INCLUSIVE.

YEARS ENDED—	Value.	YEARS ENDED—	Value.
June 30, 1873	$176,426	June 30, 1882	$449,513
1874	144,629	1883	443,996
1875	211,920	1884	367,846
1876	186,404	1885	371,679
1877	78,033	1886	302,822
1878	63,270	1887	262,357
1879	104,158	1888	322,356
1880	129,207	1889	250,187
1881	233,596		

The importation of rough and uncut diamonds in 1880 amounted to $129,207, in 1889 to $250,187, and the total for the decade was $3,133,529, while in 1883 there was imported $443,996 worth, showing that there was 94 per cent more cutting done in 1889 than in 1880, but markedly more in 1882 and 1883. This large increase of importation is due to the fact that in the years 1882 to 1885 a number of our jewelers opened diamond-cutting establishments, but the cutting has not been profitably carried on in this country on a scale large enough to justify branch houses in London, the great market for rough diamonds, where advantage can be taken of every fluctuation in the market and large parcels purchased, which can be cut immediately and converted into cash; for nothing is bought and sold on a closer margin than rough diamonds.

As will be seen by the following table, there has been a remarkable increase in the importation of precious stones in this country in the last 10 years. The imports from 1870 to 1879, inclusive, amounted to $26,698,203, whereas from 1880 to 1889, inclusive, the imports amounted to $87,198,114, more than 3 times as much as were imported the previous decade.

IMPORTS OF DIAMONDS AND OTHER STONES, NOT SET, FROM 1867 TO 1889, INCLUSIVE.

Years ended—		Years ended—	
June 30, 1867	$1,317,420	June 30, 1879	$3,841,335
1868	1,060,544	1880	6,690,912
1869	1,997,282	1881	8,320,315
1870	1,768,324	1882	8,377,200
1871	2,349,482	1883	7,598,176
1872	2,939,155	1884	8,712,315
1873	2,917,216	1885	5,628,916
1874	2,158,172	Dec. 31, 1886	9,254,438
1875	3,234,319	1887	10,686,403
1876	2,409,516	1888	10,223,630
1877	2,110,215	1889	11,705,809
1878	2,970,469		

PHOSPHATE ROCK.

PHOSPHATE ROCK.

BY EDWARD WILLIS.

SOUTH CAROLINA.

The deposits of phosphate rock in the neighborhood of Charleston and Beaufort, South Carolina, and imported guanos have furnished practically the entire supply of phosphoric acid for all the commercial fertilizers in the United States, bone having been the only other extensive source.

The history of these phosphate deposits has been recorded in various essays. Their existence was known as early as 1797, when they were mentioned by Ramsey. Since then Drayton mentioned them in 1802; Vanuxen in 1824; Shecut and Mills in 1826; Ravenel and Holmes in 1837, and Ruffin in 1844. These authorities spoke of them as extensive beds, but they were known and referred to as marl, that is, calcium carbonate, instead of phosphate. They were mentioned also by J. Lawrence Smith, Hume, Gibbs, Lyell, Tourney, and Agassiz; but they were only known as having a value for calcium carbonate. Mr. Ruffner, of Virginia, who made extended researches and applications of Virginia and South Carolina marls, had many analyses made of each, showing that they were very different in composition. Those of Virginia were easily attacked by weak acids; but the Carolina "marls" were shown to contain silica, compounds of iron, calcium phosphates, and other materials. They were not considered by him applicable to the soil until changed by burning, when he observed that they were far better and more efficient than the Virginia material.

Mr. Tourney first speaks of Charleston marl in 1848, as "marl stones", found in Ashley River basin, at Bees Ferry, at Hanckel, and at Drayton Hall. In 1850, Professor F. S. Holmes read a paper before the American Association for the Advancement of Science, calling the material "marl rock of bowlder-like masses". At that time it was analyzed by Dr. J. Lawrence Smith and Dr. C. U. Shepard, sr. A sample from Dr. Gedding's place, "The Elms", was analyzed by the latter, and declared to contain 18.60 per cent of silica, 68.01 per cent of calcium carbonate, 1.20 per cent of magnesium carbonate, 9.20 per cent of phosphates of calcium, magnesium, peroxide of iron, etc., 0.40 alumina, and 4 per cent of water.

In 1866, Dr. St. Julian Ravenel, Mr. D. C. Ebaugh, and Messrs. W. C. Dickey & Sons imported 400 tons of Navassa rock guano into Charleston. This seems to show clearly the ignorance of the existence of any considerable quantity of phosphate rock in Charleston at that time. In 1867, Dr. St. Julian Ravenel offered to supply Dr. N. A. Pratt with native phosphate rock, and at the same time agreed to take all the sulphuric acid that Dr. Pratt could make. In this same year Dr. Pratt and Professor Holmes took the initiatory steps to bring the South Carolina phosphate to the notice of capitalists, and Mr. James T. Welsman, of the firm of John Frazer & Co., furnished the first capital. Dr. Pratt and Professor Holmes then organized the Charleston Mining and Manufacturing Company, the pioneer company to use South Carolina phosphate rock, and to make it a success Messrs. George F. Lewis, F. Kent, Y. E. Smith, Samuel Fischer, and Samuel Grant, capitalists of Philadelphia, joined them, furnishing the money. The business thus inaugurated grew in importance. Many mining companies were organized and started, among them the Etiwan Company, formed by Dr. Pratt, the first company in the state to use acid chambers. From this time on the phosphate industry continued to enlarge, and, with various fluctuations of depression and prosperity, increased to the extensive operations recorded in later years.

COMPOSITION.

The crude tests as to the composition given above have, of course, been corrected by many thousands of careful analyses. The appearance and general character of the phosphate rock are quite uniform, with slight differences for land rock or river rock. But the proportion of calcium phosphate in the rock varies widely; analyses of each cargo must be made to establish its value. It is impossible to give a representative analysis, except it be based on

an average of many shipments. The following, based on several hundred shipments, may be considered a typical analysis of clean dry rock of good quality:

GENERAL COMPOSITION OF SOUTH CAROLINA PHOSPHATE ROCK.

	PER CENT.
Phosphoric acid (*a*)	26.0 to 29.0
Carbonic acid (*b*)	2.5 5.0
Sulphuric acid	0.5 2.0
Lime	35.0 42.0
Magnesia	Traces. 2.0
Alumina	Traces. 2.0
Sequioxide of iron	1.0 3.0
Fluorine	1.0 2.0
Sand and silica	4.0 12.0
Organic matter and combined water	2.0 6.0
Moisture	0.5 4.0

a Equivalent in combination to 57 to 63 per cent of bone phosphate of lime.
b Equivalent in combination to 5 to 11 per cent of carbonate of lime.

LAND AND RIVER ROCK.

There are 2 classes of phosphate deposits, land and river, the extent of the former being estimated January 1, 1890, at 55 square miles and of the latter 50 square miles. Land rock is tolerably uniform in grade. Its color varies from light yellow to heavy brown; it is nearly free from iron and alumina, but contains sufficient carbonate of lime to make an acid phosphate, and from this ammoniated or potash compounds, that promptly dry and remain in a pulverulent state after being treated with sulphuric acid. In the United States land rock has been mainly used, it being preferred to that from the rivers. River rock has, since 1870, been preferred in all foreign markets to the land rock, and much the larger part of that mined still goes abroad. In color it is from gray to blue black, with specific gravity of about 2.4 and hardness about 3.15.

The following map, outlining the deposits of land and river rock, is the work of many authorities. It was prepared for the Centennial Exposition, used again in the report of the Tenth Census, again in bulletin 46 of the United States geological survey, and now it has been brought up to date by the writer.

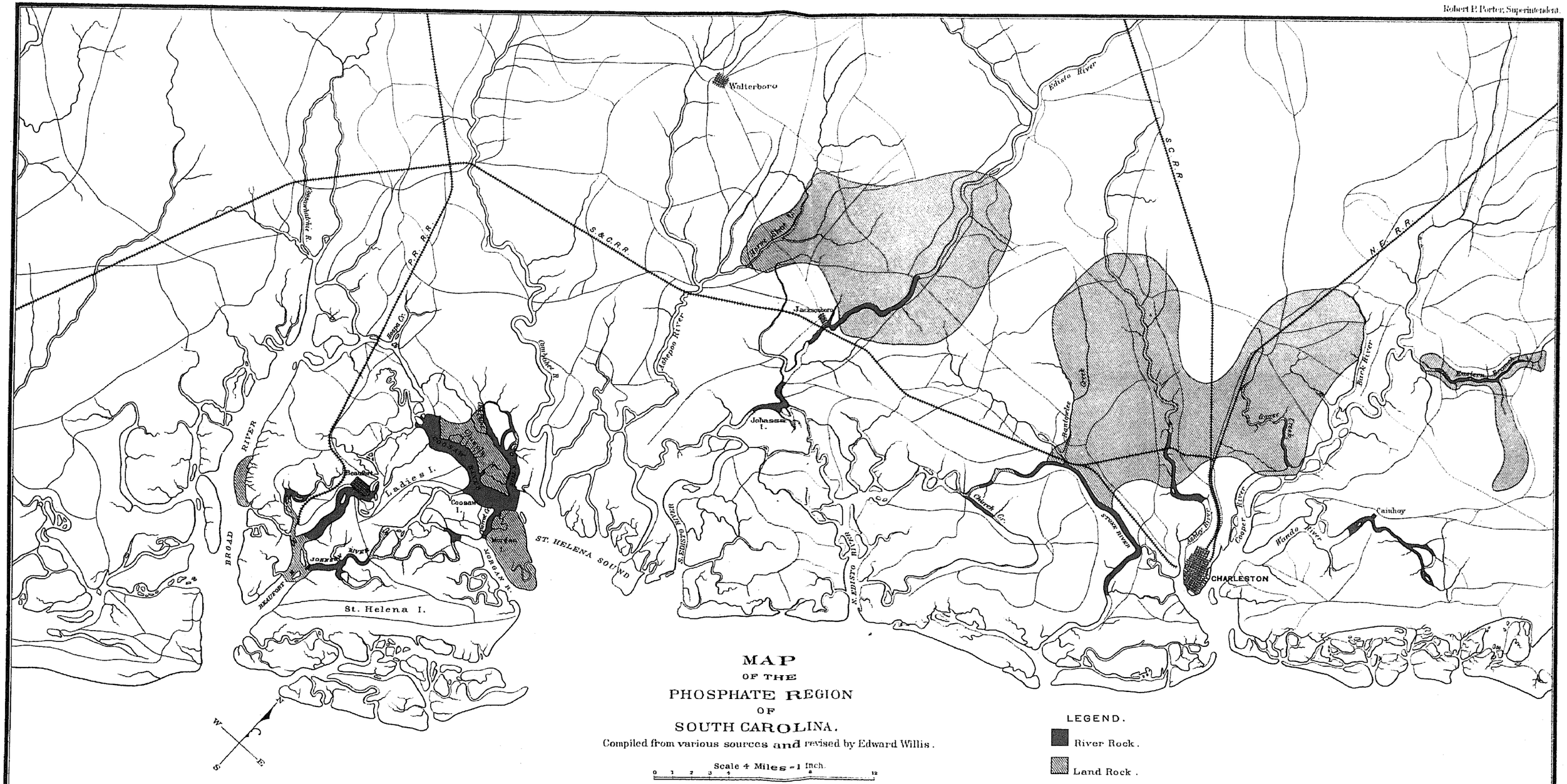
At the lower left-hand corner of the map will be seen the extensive beds at Beaufort and vicinity, and in the Beaufort river and its branches. Then, a little to the right, the Coosaw river and Chisholms island, one of the most prolific sources of phosphate rock in the state. Near the center is shown the section bordering the Edisto river and Horse Shoe creek, where workable deposits are found. There appear farther to the right the deposits of the Stono, Ashley, Cooper, and Wando rivers, and those in the neighborhood of Charleston. The colored sections do not all represent workable deposits, the lighter portions being indicative of the smaller or less profitable sections, and the darker those where mining is extensive or profitable. All the inlets from the sea in the vicinity covered by the map contain more or less phosphate rock. It is found at depths beneath the surface varying from 1 to 20 feet. The nodular stratum varies from a few inches to 2.5 feet in thickness, but the latter is rarely observed. Ordinarily it is from 10 to 15 inches and averages about 10. Where the deposit exceeds 15 inches in thickness this depth rarely extends beyond a limited area, and is generally due to local accumulation, or is the result of accidental superposition of a few large nodules. The yield per acre varies from 500 to 1,200 tons, the average yield of land beds now worked being 800 to 1,000 tons per acre. The yield per acre stands in a certain ratio to the thickness of the stratum, but not invariably so, as the compactness is an important factor in determining the amount of production. In many instances the stratum is underlaid by marl, occasionally to a depth of 250 feet.

LAND MINING.

The method of land mining of phosphate rock is simple. Long trenches are laid off, from which the overlying earth is first removed. Then by hand labor, with pick and shovel, the rock is taken from the trenches and thrown into piles, from which it is taken by barrows or carts to be washed and crushed. The laborers are usually negroes from the surrounding neighborhood and near towns or cities. Italians were employed several years ago by a number of companies, but they were soon replaced by negroes, who for climatic and other reasons are better adapted to the work.

RIVER PHOSPHATE.

River phosphate is found in deposits on river beds in depths varying from exposure at low tide to 10 or 15 feet below the surface of the water. It is occasionally found under layers of sand and mud. The nature of the deposit and the depth of the water determine, in large measure, the method of excavation. Where the rock is not over 3



MAP
OF THE
PHOSPHATE REGION
OF
SOUTH CAROLINA.

Compiled from various sources and revised by Edward Willis.

Scale 4 Miles = 1 Inch.

0 1 2 3 4 8 12

LEGEND.

River Rock.

Land Rock.

E. & G. W. BLUNT'S LITH. N. Y.

or 4 feet below the surface of the water, mining is done by hand. In deeper water dredging is resorted to. Where the rock is taken from navigable streams it is the property of the state, and is subject to a royalty of $1 per ton.

HAND PICKING.

At low water, where the bed is easily accessible, workmen with pick and shovel loosen the rock and throw it on scows or flatboats within convenient reach in shoal water. When the tide rises, the operations cease until the next low tide, and the loaded scows are moved to convenient points for shipment to washers and crushers or for transfer to vessels. The localities in which this mode of mining can be carried on are few, but they have yielded large quantities of rock at moderate cost. In the deeper water, where dredging is not resorted to, much rock is obtained by divers, who with pick and crowbar loosen the material by expertness only attained by those skilled in this particular work. A diver is enabled to bring to the surface rocks which would require the strength of 3 or 4 men to handle above water.

DREDGING.

The dredging machines are used to most advantage in about 12 feet of water. They are powerful machines, specially made for the work, of several varieties of construction, with claws and scoops capable of raising immense weights. An ordinary day's work, under favorable circumstances, lifts about 100 tons of rock. The rock, having been gathered into dippers or buckets propelled by steam, is emptied on a grating or conical washer, where it is cleansed of the mud and sand by means of heavy streams of water. Marl, sandstone, or oyster shells are then easily detected and thrown aside. The rock, which is partially cleaned, then descends, or is thrown by the machinery on a crusher, and thence into a second washer where the remaining impurities are separated.

The washing apparatus consists of either upright and caldron-shaped or shaft washers, which discharge the washed rock upon lighters for transportation to the drying sheds, where it is heaped upon and around a system of perforated iron pipes. Hot air is then forced through these pipes, and, escaping through the perforations, in a few days thoroughly dries the originally saturated rock.

MACHINERY FOR LOADING AND DISCHARGING PHOSPHATE ROCK.

The machinery for loading and discharging phosphate rock at the works of the Coosaw Mining Company will serve to explain these processes. At the first and second piers wet phosphate rock is hoisted by donkey engines from lighters, dumped into cars, and in them rolled to the drying bins, where it is piled up on the system of perforated iron pipes to be dried. At the third pier a vessel receives a cargo of dried rock, delivered directly into the hold by dumping cars, which are loaded in drying sheds from large iron buckets hoisted by steam power.

CRUSHING AND WASHING.

The machinery for crushing and washing the rock is expensive and elaborate. The washer in general use is known as the "single-screw washer". It consists of four half-circular boxes resting in a frame on an incline of 18 inches and 25 feet in length. These boxes are cased with iron. In each box is an octagonal shaft, also cased with iron, and having on each face teeth or blades set at such an angle to the shaft as to form a spiral screw, with a twist of 1 foot in 6 feet. Over each box or washer are strong cylindrical crushers or breakers, armed with steel teeth, acting against an iron plate, and set about 4 inches from the plate. Through these breakers the nodules of rock are dumped and by them broken to a uniform size of 4 inches cube. The rock is then agitated by these bladed shafts, which make about 18 revolutions per minute, and are submerged in water contained in the tub or box. The rock is forced forward and up the incline against a heavy stream of water (which enters at the upper end of the washer box) and empties itself through an overflow at that end. The abrasion of one piece of rock against another in its passage through the box rids it completely of all foreign matter, such as mud, etc. From this overflow it falls upon screens, set one above the other, the first screen having about half-inch mesh and the lower screen about quarter-inch mesh. From this lower screen the fine rock falls upon an oscillating screen still lower, which serves to rinse the small rock thoroughly. Over all these screens a flow of water passes continuously. From them the rock falls upon an elevated platform, and is thence taken to the sheds or storehouses. The water used is drawn directly from the river and forced up into large troughs by means of heavy pumps, both steam and centrifugal. The washers are considerably elevated, for the purpose of getting rid of the débris, which is carried off by means of large troughs. The loss by abrasion and clay adhering to the rock varies from 50 to 60 per cent. The capacity of each washer is from 40 to 50 tons of clean rock in 10 hours.

PRODUCTION.

The production of phosphate rock in South Carolina for the year 1889 was 541,645 long tons, valued at $2,892,276, against 448,567 long tons in 1888, valued at $2,018,552, and 480,558 tons in 1887, with a value of $1,836,818. It is thus seen that although the production in 1888 was less by 31,991 tons than in 1887, yet the value of the product increased $181,734, or 68 cents per ton. This increase in value was the result of less competition from various sources, due in part to natural conditions of mining and the purchasing ability of the consumers, who depend almost entirely upon the season's crops. The average price per ton in 1889 was $5.34, being an increase of 84 cents per ton over 1888. The increase in 1889 indicates prosperity in the states consuming phosphate rock, which is in keeping with the commercial prosperity to be noted throughout the south.

The total amount expended for wages in the production of phosphate rock, not including office force, during the year 1889, was $1,149,967, against $490,047 reported at the Tenth Census, and the capital invested $5,866,718, against $2,071,300 at the previous census. The total number of persons employed, including office force, was 4,966, against 2,485 reported at the Tenth Census.

The following table gives the annual product of phosphate rock in South Carolina since its mining became an industry, the figures given for the years previous to 1886 being for trade years, ended May 31, but after that date for calendar years:

TOTAL WASHED PRODUCT OF LAND AND RIVER PHOSPHATE ROCK IN SOUTH CAROLINA.

[Long tons.]

YEARS ENDED—	Total.	Land companies.	River companies.
May 31, 1867	6	6	.....
1868	12,262	12,262	.....
1869	31,958	31,958	.....
1870	65,241	63,252	1,989
1871	74,188	56,533	17,655
1872	58,769	36,258	22,502
1873	79,203	33,426	45,777
1874	109,340	51,624	57,716
1875	122,790	54,821	67,969
1876	132,478	50,566	81,912
1877	163,000	36,431	126,569
1878	210,322	112,622	97,700
1879	199,365	100,779	98,586
1880	190,763	125,601	65,162
1881	266,734	142,193	124,541
1882	332,077	191,305	140,772
1883	378,380	219,202	159,178
1884	431,779	250,297	181,482
1885	395,403	225,913	169,490
1885 (*a*)	277,789	149,400	128,389
Dec. 31, 1886	430,549	253,484	177,065
1887	480,558	261,658	218,900
1888	448,567	290,689	157,878
1889	541,645	329,543	212,102

a June 1 to December 31.

The table on the following page, giving the number of establishments engaged in the phosphate rock industry of South Carolina for the census years 1880 and 1889, together with the capital invested, number of hands employed, total amount of wages paid, and total product and its value, shows the steady and healthy growth of the phosphate industry in the state since the taking of the last census. It will be seen that there is an increase of $3,795,418 in invested capital, or 183 per cent; 330,268 tons in production, or 156 per cent, and $1,768,453 in value, or 157 per cent, while the number of employés (not including boys) has increased 2,437, or 101 per cent, with an increase in amount paid as wages of $659,920, or 135 per cent.

PRODUCT OF SOUTH CAROLINA PHOSPHATE ROCK IN THE CENSUS YEARS 1889 AND 1880.

YEARS.	Number of establishments.	Tons of phosphate rock mined.	Value.	NUMBER OF HANDS EMPLOYED.		Amount paid in wages.	Capital invested.
				Males over 16 years.	Males under 16 years.		
1889	25	541,645	$2,892,276	4,842	90	$1,149,967	$5,866,718
1880	21	211,377	1,123,823	2,405	70	490,047	2,071,300
Increase	4	330,268	1,768,453	2,437	20	659,920	3,795,418
Percentage of increase	19	156	157	101	29	135	183

The following table gives the number of persons employed in phosphate-rock mining in the state of South Carolina, together with the average wages per day of each class and the average number of days employed:

LABOR EMPLOYED IN PHOSPHATE-ROCK MINING IN SOUTH CAROLINA IN 1889.

DISTRIBUTION.	Number.	Average wages per day.	Average number of days employed.
Total	4,932		
Foremen	106	$2.23	242
Mechanics	128	2.51	248
Laborers	4,608	0.97	225
Boys under 16 years	90	0.51	161

OPERATING EXPENSES.

Wages (including office force at mines)	$1,190,622
Paid contractors	115,430
Paid for supplies	313,359
Paid for other expenditures	342,648
Total	1,962,059

The phosphate trade in South Carolina is greatly stimulated by the favorable location of the beds in respect to the field of greatest consumption, namely, the southern states, which annually consume about 375,000 tons of commercial fertilizers. This in great measure prevents the foreign article from becoming a serious competitor, and in proportion increases trade throughout the state. Another stimulant to trade is the fact that large quantities of phosphate are shipped to various ports as ballast under cotton. Thus cheap transportation is secured, and in proportion the cost of the fertilizer is lessened to the consumer. The rock is especially adapted for the manufacture of commercial fertilizers, it being remarkably free from gangue rock and other impurities, and is readily ground to the necessary fineness for complete decomposition by sulphuric acid. Kiln-dried rock constitutes more than half of the phosphate now delivered for manufacture in the state of South Carolina.

ROYALTIES.

In 1870 the legislature of South Carolina imposed a royalty of $1 per ton on all phosphate rock taken from the navigable streams of the state. The royalty thus exacted has proved a most important feeder to the state's treasury, the amount obtained from this source up to and including 1889 exceeding the sum of $2,000,000.

The following table shows the distribution, by years, of the sum thus obtained from 1870 to 1889, inclusive:

AMOUNT OF ROYALTY REALIZED BY THE STATE OF SOUTH CAROLINA FROM PHOSPHATE MINING, 1870 TO 1889, INCLUSIVE.

1870	$1,989	1876	$81,912	1882	$140,772	1887	$208,772
1871	17,655	1877	126,569	1883	125,793	1888	186,994
1872	22,502	1878	97,700	1884	153,798	1889	212,102
1873	45,777	1879	98,586	1885	176,755		
1874	57,716	1880	65,314	1886	196,090	Total	2,199,320
1875	57,969	1881	124,555				

PRICES.

The price of kiln-dried land rock varied in 1889 from $6 per ton (free on board vessel) in January to $6.75 in December. Ground rock, which is about 99 per cent of land rock, averaged $8 per ton (free on board vessel) for the first 5 months of the year and then advanced to $8.50, which was the closing quotation for the year. Sales free on board cars were nearly uniform at $7.75. Kiln-dried river rock was worth $5.50 (free on board vessel) in January; in June the price had advanced to $6.50, and in December offers of $7.75 per ton were made for a cargo for foreign shipment. Compared with 1888, the figures show a general increase in price except in December, 1889, when there was a decrease of 25 cents per ton compared with the same month in 1888. Land rock sold in January, 1888, at $4 per ton for crude and $5 for kiln-dried; in August the price advanced to $5 and $6 for crude and kiln-dried, respectively, and these figures prevailed to the close of the year. River rock opened at $4 and $5, respectively, for crude and dried, and advanced to $4.75 and $5.75, and so continued throughout the year. Ground rock was worth $6.50 per ton at the beginning of the year, advancing from this figure to $7.50 in August to $8 in December.

The following table shows the shipments of crude phosphate rock from the cities of Beaufort and Charleston from the year 1867, when it first became an industry, to 1889, together with the amount of local consumption for the same period at those places. It will be seen that the shipments to foreign ports for the year 1889 from Beaufort were 137,102, against 185,850 tons in 1888, showing a decrease of 48,748 tons. The domestic shipments for 1889 were 60,000 tons, against 29,834 tons for 1888, an increase of 30,166 tons, while there was an increase in the local consumption of 3,000 tons. The foreign shipments from Charleston for 1888 were 3,800 tons, for 1889 5,900 tons, giving an increase of 2,100 tons. The domestic shipments for 1888 were 208,000 tons, against 248,643 tons for 1889, showing an increase over the preceding year of 40,643 tons, while the local consumption at Charleston is reported as 75,000 tons, being the largest amount recorded to the close of the calendar year 1889.

The total foreign shipments for the years from 1867 to 1889, inclusive, are given as 2,003,487 tons; domestic shipments, 2,433,217 tons; local consumption, 741,047 tons; making a grand total of 5,177,751 tons, with a value of $33,000,000.

SHIPMENTS AND CONSUMPTION OF CRUDE PHOSPHATE AT BEAUFORT AND CHARLESTON, 1867 TO 1889, INCLUSIVE.

[Long tons.]

YEARS.	BEAUFORT.			CHARLESTON.		
	Foreign ports.	Domestic ports.	Consumption.	Foreign ports.	Domestic ports.	Consumption.
Total	1,689,802	423,804	66,900	313,685	2,009,413	674,147
1867	.....	.....	.....	.....	6	.....
1868	.....	.....	.....	208	11,654	.....
1869	.....	.....	.....	3,760	24,511	.....
1870	1,980	604	.....	13,652	40,099	.....
1871	28,431	5,064	.....	14,093	16,843	12,000
1872	17,540	3,180	.....	15,628	25,955	10,000
1873	24,600	4,765	.....	2,435	27,403	15,000
1874	44,857	10,500	.....	7,688	31,930	16,000
1875	44,617	7,000	.....	25,929	25,560	19,680
1876	59,834	9,400	.....	25,431	28,831	18,850
1877	73,923	6,285	.....	28,844	40,768	15,000
1878	100,619	8,217	.....	21,123	60,729	17,635
1879	97,799	8,618	.....	21,767	52,281	18,900
1880	47,157	13,346	.....	14,218	94,012	22,040
1881	62,600	65,895	.....	8,568	91,929	38,142
1882	89,581	57,645	.....	22,905	111,314	42,900
1883	94,789	36,175	.....	28,251	150,545	42,000
1884	132,114	34,711	5,900	21,495	187,700	51,000
1885	112,000	32,000	12,000	11,490	161,700	55,000
1886	153,409	14,600	9,000	6,800	187,000	60,000
1887	190,000	15,905	13,000	9,700	182,000	70,000
1888	185,850	29,834	12,000	3,800	208,000	75,000
1889	137,102	60,000	15,000	5,900	248,643	75,000

RECAPITULATION.

[Long tons.]

PORTS OF SHIPMENT.	To foreign ports.	To domestic ports.	Local consumption.	Total.	Value.
Total	2,003,487	2,433,217	741,047	5,177,751	$33,000,000
Beaufort	1,689,802	423,804	66,900	2,180,506	13,500,000
Charleston	313,685	2,009,413	674,147	2,997,245	19,500,000

The question of the supply of phosphate rock from the river and land beds in the future has been discussed at different times by various authorities, who have attempted to estimate the tonnage available for commercial mining; but these estimates vary so widely as to destroy the value of any conclusions based on them. Professor C. U. Shepard, jr., put the figure at 5,000,000 tons; Professor Otto W. Moses at 9,000,000 tons, and Professor H. Colton's estimate is 576,000,000 tons. The first of these estimates has already been exceeded; the second has not yet been reached, and it is doubtful if the last will ever be.

FLORIDA.

The occurrence of phosphate rock of low grade in this state has been known since 1883, when noticed by Professor Lawrence C. Johnson, but in 1888 discoveries were made of deposits of large extent and high in their percentage of phosphoric acid. These deposits have continued to attract attention, have been the scene of speculation, and have been developed with great rapidity and enterprise.

DISCOVERIES PRIOR TO 1888.

It was known in 1882 that phosphate deposits could be found following an irregular line from Thomasville, Georgia, down through Hamilton, Suwannee, Alachua, Marion, Sumter, and Polk counties, disappearing in Manatee county, in the region of Charlotte harbor. They had been noticed more particularly from Live Oak, Suwannee county, to Ocala, Marion county, and attention had been paid only to this region. The region north has been traced by popular report, not by careful survey. These deposits are in high land, and the line of phosphates is generally coincident with the upper part of a ridge running approximately north and south. Commencing with the upper limits of the deposit it is impossible to say how much of the rock is really phosphatic and how much is Vicksburg limestone, with which it has been confused. From Live Oak to Ocala there is little of the limestone, but the phosphate rock is very abundant. It is usually a very porous rock, containing through its mass the bones and teeth of various vertebrates. In badly drained spots it is wet and then soft, so that it is easily broken, but on drying it becomes so much harder that it is valued as a building stone, and has been so much used for chimneys and underpinning for houses that it is known as "chimney rock". The ridge with its phosphate deposits skirts the great region of depression, which includes the sinks of Alachua county. 3 miles north of Waldo, in this county, there is a large dry sink in which Mr. John A. Preston found phosphate rock containing 25 per cent of phosphoric acid at a depth of 50 to 75 feet. At Fort Harley, near by, deposits have also been found, and again on the borders of Santa Fe lake. The Devil's Millhopper is another sink, about 5 miles west of Gainesville, which contains quantities of loose bowlders of phosphate rock. Near it is a large quarry of building rock, also phosphatic. 3 miles west of Hawthorne there is a deposit of 35 to 50 acres, called Simmons Quarry, from which samples have been taken showing 45 per cent of calcium phosphate. Similar deposits have been described near Newnansville. Little attention has been paid to these deposits, although in 1883 Dr. C. A. Simmons, of Hawthorne, began quarrying the rock and converting it into a fertilizer. Many other isolated deposits had been noticed in the state before attention was prominently called to Florida by the developments of 1888. Among such deposits was one passed through in digging the pump well for the Jacksonville waterworks. At a depth of 20 feet a thin layer of greenish marl containing considerable phosphate was observed.

In 1886 phosphate rock of high grade was discovered on the Peace river. The Arcadia Phosphate Company has made extensive developments on rock there exposed in the river bed. A permanent bridge has been built, and drying kilns, hoisting machinery, and screens are in operation. In 1888 the company began shipments, which amounted to 3,000 tons. The richest rock is in the form of coarse sand from the river bar.

RECENT DISCOVERIES.

The year 1888 also developed an entirely different class of phosphate deposits, of undoubtedly great value to the state, and which have attracted attention in all parts of the United States, and even in Europe. At the close of 1888, Mr. Albertus Vogt, living near Dunnellon, a village on the Withlacoochee river, in Marion county, found fossil teeth in a white subsoil. Some of this white soil was submitted to a chemist for analysis, and found to contain a large proportion of phosphate of lime. This soil was soon found to extend in a more or less pockety belt over a district some 30 miles long and 6 wide. Active exploration began at once and extended rapidly, with the usual speculative excitement of such discoveries. The fact is well established that much of the material is of unusually high grade, the highest in the United States. This developmental and speculative work was the main feature of the census year.

The following table shows the expenditures made in regular mining:

STATISTICS OF PHOSPHATE MINING IN FLORIDA IN 1889.

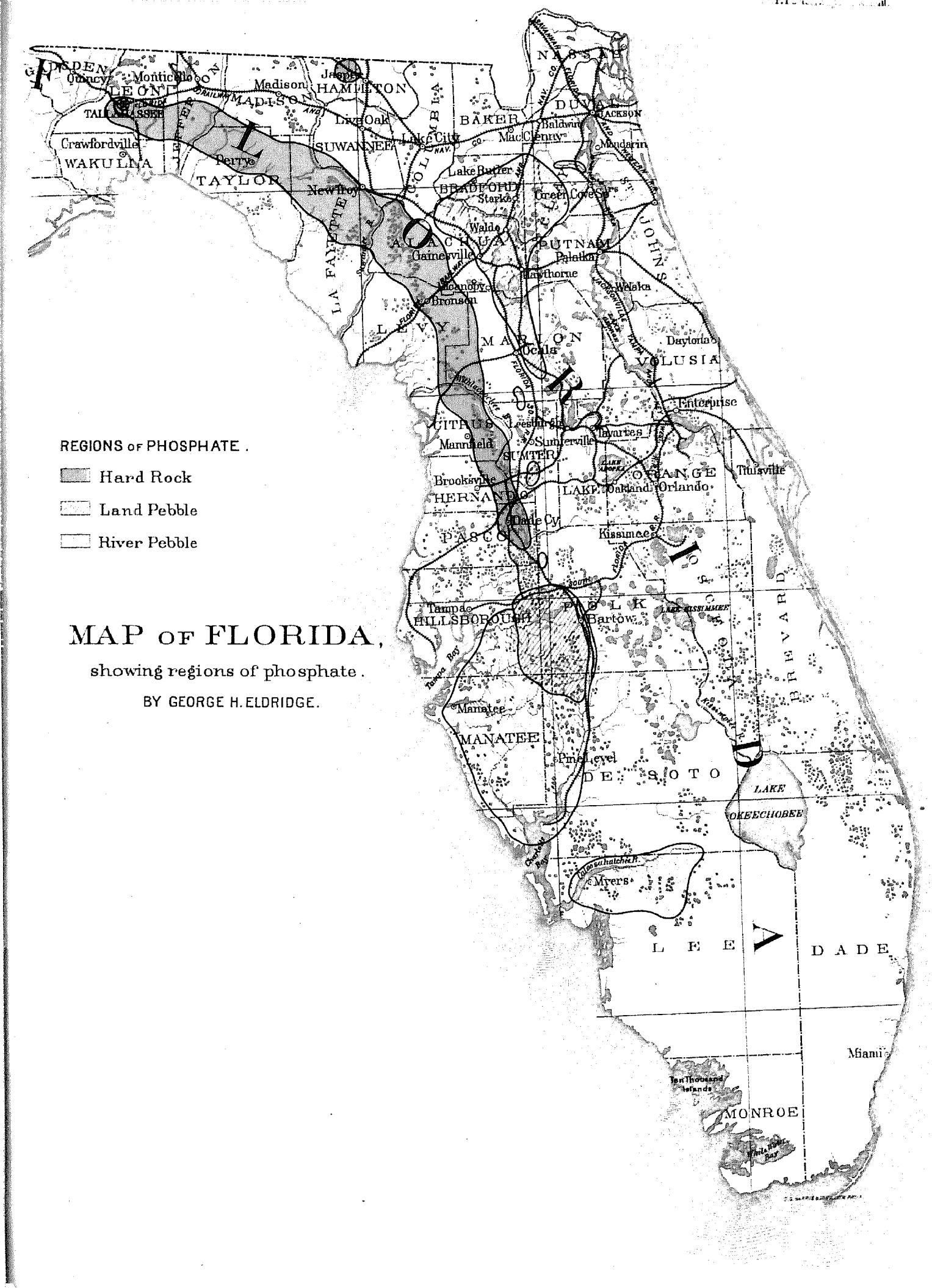
Total phosphate rock produced (long tons)	8,100
Total phosphate rock sold (long tons)	4,100
Stock on hand January 1, 1890 (long tons)	4,000
Total value of product	$40,500
Expenditures:	
Total wages (including office force at mines)	$17,404
Paid for supplies	1,800
Paid for other expenditures	523
Total	19,727
Capital invested:	
In land	$130,000
In buildings	22,000
In tools and machinery	8,000
Cash	5,000
Total	165,000

LABOR EMPLOYED.

EMPLOYÉS.	Number.	Average rate of wages per day.	Average number of days employed.
Total	64		
Foremen	4	$2.25	250
Mechanics	2	1.75	200
Laborers	57	1.25	205
Boys	1	0.75	90

Florida phosphates may be divided into 4 classes, namely, the hard rock, the soft rock, the land pebble, and the river pebble.

Of the hard rock phosphate there are certain local variations: the massive rock itself; the laminated rock, in which there are narrow layers of phosphate separated by the equally narrow interspaces, and the plate phosphate, which is probably derived from the laminated variety, and is thus far found only in one or two localities in Florida in the more recent deposits. The hard rock phosphate is white, creamy, gray, or yellowish-brown in color, and varies in texture and structure from one of homogeneous appearance to a brecciated variety and to still others carrying considerable sand and clay. It is sometimes stained in a slight degree with iron, and always contains more or less alumina. The percentage of phosphate of lime contained in this class of rock is between 80 and 86. The extent of the hard rock phosphate as thus far developed is from a point about south of Tallahassee, following the line of the gulf at a distance of from 20 to 30 miles, around to a little below Dade City, in peninsular Florida. Its length is a little less than 200 miles. The deposit is not continuous, but may occur at any point within its length. It also extends into the north of Florida quite to the Georgia line, in the vicinity of the Suwannee river. The width of the belt is between 6 and 10 miles. Mining is by open pits, and in the case of the older and better organized companies is conducted with the most approved plants. The character of the occurrence of the hard rock phosphate has not been altogether satisfactorily determined, but the evidence is in favor of a mass or masses of bowlders piled together over areas of greater or less extent. The actual depth of any of these piles has not been determined, the greatest depth yet reached being about 60 feet from the surface. From an inspection of the deposits one would be led to think that their materials have not been transported far from the beds of which they originally formed a part. Hard rock phosphate bowlders have been derived from rocks of two geological ages, one eocene, which has the widest areal distribution, and the other, miocene, which is found within the so-far comparatively limited area southeast of Tallahassee. In the vicinity of Dunnellon, where the hard rock region is crossed by the Withlacoochee river, the phosphate has been broken down, and is now dredged from the bottom of the stream in a form somewhat altered from its original condition, or as pebbles. Vertebrate remains occur in abundance. Hard rock phosphate has also been mined near Boston, Georgia, a station on the line of the Savannah, Florida and Western railroad, just north of the Florida boundary.


REGIONS OF PHOSPHATE.
Hard Rock
Land Pebble
River Pebble
MAP OF FLORIDA,
showing regions of phosphate.
BY GEORGE H. ELDRIDGE.
Quincy
Monticello
Madison
Jasper
LEON
MADISON
HAMILTON
NASSAU
DUVAL
JACKSON
TALLAHASSEE
Live Oak
BAKER
Baldwin
Jacksonville
Crawfordville
WAKULLA
SUWANNEE
Lake City
MacClenny
Mandarin
Perryo
TAYLOR
Lake Butler
Newtroy
BRADFORD
Starke
Green Cove Sp'rs
Waldo
ALACHUA
Gainesville
PUTNAM
Palatka
Hawthorne
Micanopy
Welaka
Bronson
LEVY
MARION
Ocala
Daytona
VOLUSIA
Enterprise
CITRUS
Leesburg
Tavares
Sumterville
Mannfield
SUMTER
Brooksville
ORANGE
Oakland
Orlando
Titusville
HERNANDO
LAKE
Dade Cy
PASCO
Kissimee
POLK
Tampa
HILLSBOROUGH
Bartow
LAKE KISSIMMEE
Manatee
MANATEE
Pinellevel
DE SOTO
LAKE
OKEECHOBEE
Myers
LEE
DADE
Miami
Ten Thousand Islands
MONROE

ANALYSIS OF PHOSPHATE ROCK FROM LURAVILLE, FLORIDA.

	PER CENT.
Phosphoric acid, P_2O_5	33.91
Lime, CaO	47.02
Alumina, Al_2O_3	2.37
Ferric oxide, Fe_2O_3	1.46
Magnesia, MgO	0.39
Alkalies, Na_2O	0.19
Sulphuric acid, SO_3	0.36
Fluorine, Fl	2.35
Chlorine, Cl	0.08
Silica (dissolve), SiO_2	0.10
Carbonic acid	2.67
Insoluble matter	5.07
Water at 105°	1.18
Water at red heat	2.78
	99.93

The soft rock phosphate occurs both as a deposit by itself and in the deposits of hard rock, filling the spaces between the bowlders. It may be either clayey or sandy in its nature. It falls considerably below the hard rock in the percentage of phosphate of lime, and naturally shows a higher percentage.

The land pebble phosphate is found in a number of localities in peninsular Florida, the center of production at present being in Polk county, within a radius of 18 miles of Bartow. Thus far it has been worked only to the west of Peace river, within 12 or 15 miles of it, but prospectors have reported its occurrence beneath a large part of the surface between Peace river and the Gulf. It is essentially a mass of white phosphate pebbles lying in a matrix of phosphatic clay or sand, usually a combination of the two. The matrix is easily disintegrated by water and the pebbles are washed out by appropriate machinery. The pebbles vary in size from grains to 1 inch in diameter, the average being between one-quarter and one-half an inch. They are hard, and usually pure white or cream colored on fresh fracture. The percentage of phosphate which they contain is between 75 and 80 per cent, but the yield of the rock as mined would not reach this standard, in fact falls considerably below it. The land pebble is found in several parts of Florida; in the vicinity of Bartow; in connection with the plate rock at Anthony and Sparr, 10 miles north of Ocala, and again northeast of Gainesville, occupying here an extensive area. The age of the land pebble deposits is probably older pliocene. The methods of mining the land pebble are being rapidly developed, the most complete plant being that of the English Company, 7 miles south of Bartow, where, under the favorable condition existing, enormous basins have been dug in which dredges of great capacity are floated. The pebble is dredged, washed by machines adapted to the purpose, dried, and then shipped.

The river pebble is found in bars in the rivers of southern Florida, the greatest production at present being the Peace river, which furnishes nearly the entire product. The other rivers in southern Florida that are known to carry river pebble in quantity are the Alafia, the two Manatees, and the Caloosahatchee; in northeast Florida, Black creek, a tributary to the Saint Johns, which enters the latter stream about 20 miles south of Jacksonville, also yields a small amount. Pebble phosphates are also found in many other streams entering the Gulf, but thus far not in workable quantities. With the pebbles are often found the remains of vertebrate animals. The river pebble is blue or black in color, of a size from 1 inch down, usually finer as distance down stream is gained. It occurs as pebbles, or more rarely as the hardened casts of small mollusks, which show some attrition by water. In the Caloosahatchee the pebble is mixed with ordinary shells of carbonate of lime washed out from the pliocene and postpliocene beds bordering the river above. The derivation of the river pebble is probably very largely from the land pebble deposits, the streams in which they occur draining the country occupied by these deposits. Some of them may also have been derived from the hard rock phosphate. The percentage of phosphate of lime in the river pebble is between 58 and 68 per cent, the average of the cargoes running between 60 and 65 per cent. The river pebble is dredged, washed, and floated on the river to the works, where it is then dried, cleaned, and made ready for shipment. The phosphate-drying works are very extensive.

NORTH CAROLINA.

Phosphates have been known to exist in the state of North Carolina for a number of years, but it was not until 1884 that they were fully examined. In that year Professor Charles W. Dabney, jr., of the state geological survey, made a thorough investigation and examination, and found them to be of 2 classes. First, amorphous nodules, very much resembling those of South Carolina, and, second, conglomerates, in which the pebbles are phosphate and the matrix a white calcareous rock. The first are of poor quality, occurring in small quantities, varying widely in quality of chemical constituents, and commercially of little value. Their locality is principally in the southern and southeastern portions of the state, in the counties of Sampson, Pender, Onslow, Duplin, Columbus, and New Hanover. In shape the nodules are flat, in this respect differing from those of South Carolina, which appear to have no definite form.

The phosphatic conglomerates consist of a mass of tertiary teeth, bones, nodules, and quartz pebbles, in connection with grains of greensand, with which they are cemented together in a calcareous matrix. These conglomerates are found principally in New Hanover and Pender counties. They exist in beds from 1 to 6 feet in depth. As the depth increases they grow smaller in size. The largest scarcely exceed in size an ordinary walnut, but at the greatest depth the smallest are of the dimension of a buckshot. The whole mass of conglomerate does not contain over 10 to 20 per cent of phosphate of lime. It has been ground by several companies in the state, by whom it is sold to local consumers, who have used it with some success as a fertilizer.

STATISTICS OF PRODUCTION OF PHOSPHATE ROCK IN NORTH CAROLINA.

Total product (short tons)	500
Total value	$5,000
Employés:	
Laborers (number)	15
Average rate of wages	$0.75
Average number of days employed	100
Expenditures:	
Total wages paid	$1,125
Paid contractors	500
Paid for supplies	2,000
Paid for other expenditures	100
Total	3,725
Capital invested:	
In land	$90,000
In buildings and fixtures	5,000
In tools and machinery	5,000
Total capital	100,000
Power:	
Steam boilers (total 50 horse power)	2
Steam engine (15-inch cylinder)	1
Horses employed	3

ALABAMA.

In Alabama there is a belt running across the state from east to west just below its middle, and included between parallels of latitude 32° and 33°, locally known as the "black belt". In this belt, particularly in the central and western parts, greensand marls and phosphatic nodules have been found, which promise fully as well as the Florida phosphates did a few years ago. Some effort has been made to develop these deposits, and the phosphatic marls particularly have been used locally, but the district is not well supplied with transportation facilities at present. The northern boundary is a line drawn from Columbus, Georgia, westward through Tuskegee, Montgomery, Marion, Greensboro, and Eutaw, Alabama, on to Columbus, Mississippi. The belt extends southward from this line for 20 to 50 miles. In the eastern parts of the state it is covered by the drift to such a depth as to be practically useless. In the central and western part of the state the belt is well exposed. Under a stratum of green sand marl 5 to 6 feet thick occurs a sandy, indurated nodular rock 2 feet thick, cemented by carbonate of lime, which yields from 200 to 800 tons per acre of phosphatic nodules, yielding 20 to 38 per cent of phosphoric acid.

As soon as the approaching era begins of fertilizing by the application of calcined phosphates directly to the land, these deposits will be great sources of wealth, and a region now little known will in due time be very valuable. No work was done on these deposits in 1889.

STATISTICS OF PHOSPHATE ROCK PRODUCTION IN THE UNITED STATES IN 1889.

AMOUNT AND VALUE OF PHOSPHATE ROCK PRODUCED IN 1889.

[Long tons.]

STATES.	Amount produced.	Amount sold.	Value of product.
Total	550,245	547,609	$2,937,776
South Carolina	541,645	543,009	2,892,276
Florida	8,100	4,100	40,500
North Carolina	500	500	5,000

LABOR AND WAGES.

STATES.	FOREMEN.			MECHANICS.			LABORERS.			BOYS UNDER 16 YEARS.		
	Number.	Average wages per day.	Average number of days employed.	Number.	Average wages per day.	Average number of days employed.	Number.	Average wages per day.	Average number of days employed.	Number.	Average wages per day.	Average number of days employed.
Total	110	$2.23	242	130	$2.50	247	4,680	$0.97	224	91	$0.51	160
South Carolina	106	2.23	242	128	2.51	248	4,608	0.97	225	90	0.51	161
Florida	4	2.25	250	2	1.75	200	57	1.25	205	1	0.75	90
North Carolina							15	0.75	100			

OPERATING EXPENSES.

STATES.	Total expenditures.	Wages, including office force.	Paid contractors.	Paid for supplies.	Other expenditures.
Total	1,985,511	1,209,151	115,930	317,159	343,271
South Carolina	1,962,059	1,190,622	115,430	313,359	342,648
Florida	19,727	17,404		1,800	523
North Carolina	3,725	1,125	500	2,000	100

CANADIAN APATITE.

The supply of Canadian apatite comes from the vicinity of Ottawa, Perth, and Kingston, but it is to be found in varying quantities throughout the Laurentian chain of mountains. It is mined by regular companies in many instances, but in others by farmers during time otherwise unoccupied at their agricultural pursuits. It is generally discovered in irregular veins or in pockets, in connection with feldspar, gneiss, limestone, mica, and other rocks, which appear on the surface or penetrate deep into the soil. The apatite is separated by hand dressing, that is, simply breaking off the adhering rock by means of a common gavel or a hammer. This process is slow and, in proportion, expensive, and necessarily lessens the production. The difficulties of transportation are also great, much of the crude product being hauled over rough mountainous roads to water routes and railroads. It is not likely that the entire output of the region producing apatite will greatly exceed, under the most favorable circumstances, 20,000 tons per annum, with an average market value of $15 per ton.

Canadian apatite is easily crushed, but its pulverization is difficult, and it does not readily mix with acid in the manufacture of superphosphates. It contains a high amount of fluoride of calcium, and generates on treatment with sulphuric acid a large amount of hydrofluoric acid, thus requiring special arrangements in the works for ventilation because of the poisonous gases thrown off. Notwithstanding the impurities associated with it, Canadian apatite is sometimes obtained quite clean, and often with 70 to 80 per cent of bone phosphate of lime, and when intelligently handled will yield a superphosphate containing about 20 per cent soluble phosphoric acid.

MARL.

MARL.

BY JEFFERSON MIDDLETON.

The total product of marl in the United States at the Eleventh Census amounted to 139,522 long tons, valued at $63,956. The production is limited to 5 states, namely, New Jersey, North Carolina, Virginia, Alabama, and Arkansas. The production of the last 4 states is very small, being but 1,405 tons, with a value of $2,253.

At the Tenth Census no statistics in regard to marl were published. The production in New Jersey during the census year was 138,117 tons, valued at $61,723. The industry is conducted almost exclusively by farmers, there being but 3 organized companies engaged therein, and these produced only 10 per cent of the entire output during the period under review. The season during which marl is dug begins in October and ends about May 1, thus enabling the producers to work during the leisure time of winter.

The production during 1889–1890 was small as compared with other years, which was due in part to the mild and rainy weather which prevailed that winter, seriously affecting the condition of the roads and making hauling difficult. Further and more potent reasons, as stated in Mineral Resources of the United States, 1888, are the increased use of more easily applied manufactured fertilizers, and the general opinion that the effects of marl are comparatively lasting, and, the land having received a thorough application it is not necessary for some years to use it so extensively as was done in the early part of the last decade. During the period just referred to immense quantities of marl were used all over the state of New Jersey, in some years reaching nearly 1,000,000 tons, and many farmers think that the land has received so much marl that new applications have very little, if any, effect. The marl belt of the state extends from Raritan bay to the head of the Delaware bay, with an average width of from 10 to 14 miles, and marl is accessible on most of the farms situated within this belt. The only deposit in the state outside of the limits mentioned occurs in Cumberland county, in the neighborhood of Shiloh.

The methods of disposing of the marl are either to sell on the bank, ready for hauling, in which case the seller does the digging, or to sell the marl in place, the purchaser getting it out. Then, again, a farmer who has a pit on his premises takes out what he needs and puts it on his land, and in many cases no account is kept even of the quantity used. It will be readily seen that from the nature of the business accurate statistics of labor and wages are impossible to obtain, so in this particular industry no attempt has been made to tabulate the statistics, it being deemed sufficient to give the production and value.

As to the capital involved, the same condition of affairs exists, the large area of marl land making it impracticable to arrive at its value by the tests applied to other mineral deposits, for the reason that many farms having marl beds under them are at present more valuable for farming purposes than as mineral lands.

GYPSUM.

GYPSUM.

BY E. W. PARKER.

PRODUCTION.

The amount of crude gypsum produced in the United States in 1889 was 267,769 short tons. The value ranges between 75 cents and $2 per ton, according to quality, but as only a small portion of the product is sold in its crude state it is deemed expedient to show how much of the total product was sold crude, how much was calcined into plaster of paris or stucco, how much was manufactured into cement, and the amount ground into fertilizer known as "land plaster", with the value of each. In each instance the number of men employed and the amount of wages paid represent the labor and expense required to bring the mineral to the condition for which the value is given; that is, the price at which it was first sold. The same may also be said of the statistics of the capital invested in the industry. The states and territories producing gypsum in 1889 were California, Colorado, Iowa, Kansas, Michigan, New York, Ohio, South Dakota, Utah, Virginia, and Wyoming, as shown in the following table:

PRODUCTION OF GYPSUM IN 1889, BY STATES AND TERRITORIES.

STATES AND TERRITORIES.	Total amount produced. (Short tons.)	Total value.	Amount sold in crude state. (Short tons.)	Value.	Amount sold as land plaster. (Short tons.)	Value.	Amount of gypsum calcined into plaster of paris or stucco. (Short tons.)	Amount of plaster of paris or stucco after calcining. (Short tons.)	Value.
Total	267,769	$764,118	73,243	$82,704	108,771	$233,307	85,755	64,711	$448,107
California	3,000	30,000	.....	.....	.....	.....	3,000	2,250	30,000
Colorado	7,700	28,940	.....	.....	100	140	7,600	4,325	28,800
Iowa	21,784	55,250	.....	.....	14,434	23,000	7,350	5,597	32,250
Kansas	17,332	94,235	.....	.....	.....	.....	17,332	a13,896	94,235
Michigan	131,767	373,740	35,100	35,100	54,084	123,143	42,583	32,434	215,497
New York	52,608	79,476	21,537	21,642	31,071	57,834	.....	.....	.....
Ohio	9,920	51,491	106	212	2,744	9,604	7,070	5,656	41,675
South Dakota	320	2,650	.....	.....	.....	.....	320	253	2,650
Utah	b16,000	25,000	16,000	25,000	.....	.....	.....	.....	.....
Virginia	6,838	20,336	500	750	6,338	19,586	.....	.....	.....
Wyoming	c500	3,000	.....	.....	.....	.....	500	390	3,000

a Of the Kansas product 600 tons were made into fireproof cement, producing 400 tons of cement, valued at $6,000.
b Estimated, and value given for crude material.
c Began operations November 1, 1889.

LABOR AND WAGES.

The highest rate of compensation to foremen above ground was $5 per day, paid at Iowa quarries; the lowest, $1 per day, paid in Virginia. The highest wages paid mechanics was paid in Colorado, $3 per day; the lowest, $1 per day, paid in Virginia. Ordinary labor above ground received as the highest pay $2 per day, and as the lowest 75 cents. The former rate was paid by one firm in New York state and by all operators in South Dakota, Wyoming, Colorado, and California. The lowest rate was paid in Virginia. About 77 per cent of the labor was employed above ground.

LABOR EMPLOYED AT GYPSUM MINES IN 1889.

EMPLOYÉS.	Average number employed.	Highest wages paid.	Lowest wages paid.	Average wages per day.	Average number of days worked.
Total	761				
Above ground:					
Foremen	35	$5.00	$1.00	$2.54	236
Mechanics	84	3.00	1.00	1.96	225
Laborers	460	2.00	0.75	1.40	204
Boys under 16 years of age	7	0.75	0.44	0.50	144
Below ground:					
Foremen	11	3.00	1.00	1.82	195
Miners	67	3.00	0.75	1.44	186
Laborers	97	2.50	0.75	1.20	181

OPERATING EXPENSES.

Wages (including office force at mines or quarries)	$249,200
Paid contractors	10,031
Paid for supplies	128,854
Paid for other expenditures	45,262
Total	433,347

CAPITAL INVESTED.

In land	$1,513,250
In buildings, machinery, etc	540,610
In tools, implements, live stock, etc	318,080
In cash (not reported in foregoing items)	101,235
Total	2,473,175

MOTIVE POWER.

There were 24 producers who used steam power at their works, in all 33 boilers, with an aggregate of 2,045 horse power. The number of animals employed during the year at gypsum works was 284.

STATISTICS OF PRODUCTION OF GYPSUM IN THE UNITED STATES IN 1889, BY STATES AND TERRITORIES.

STATES AND TERRITORIES.	Total amount of gypsum produced. (Short tons.)	Value.	Total expenditures.	Wages, including office force at works.	Paid contractors.	Paid for supplies.	All other expenditures, including rent, taxes, insurance, etc.
Total	267,769	$764,118	$433,347	$249,200	$10,031	$128,854	$45,262
Colorado	7,700	28,940	20,667	12,175	3,000	4,467	1,025
Iowa	21,784	55,250	26,218	11,668	3,050	8,000	3,500
Kansas	17,332	94,235	75,874	35,195	1,156	34,281	5,242
Michigan	131,767	373,740	200,961	107,078	1,700	66,706	25,447
New York	52,608	79,476	59,707	41,054	.....	11,055	7,598
South Dakota	320	2,650	4,670	3,570	1,000	.....	100
Utah	16,000	25,000	11,294	9,544	.....	1,000	750
Virginia	6,838	20,336	10,066	8,396	125	745	800
Other states (a)	13,420	84,491	23,920	20,520	.....	2,600	800

a There are here grouped, in order that the business of individual establishments may not be disclosed to the public, California, Ohio, and Wyoming.

LABOR EMPLOYED IN GYPSUM MINES IN 1889, BY STATES AND TERRITORIES.

STATES AND TERRITORIES.	ABOVE GROUND.											
	Average number employed.				Average wages per day.				Average number of days worked.			
	Foremen.	Mechanics.	Laborers.	Boys under 16 years.	Foremen.	Mechanics.	Laborers.	Boys under 16 years.	Foremen.	Mechanics.	Laborers.	Boys under 16 years.
Total	35	84	460	7	$2.53	$1.97	$1.40	$0.50	235	222	201	144
Colorado	3	6	15	.....	3.00	2.58	2.00	.....	221	200	103	.....
Iowa	3	6	50	.....	2.83	2.38	1.50	.....	151	61	138	.....
Kansas	5	14	42	.....	2.95	2.11	1.38	.....	267	291	222	.....
Michigan	10	39	131	1	2.65	1.88	1.38	0.50	310	270	266	150
New York	6	6	125	1	1.83	1.76	1.38	0.75	200	189	181	300
South Dakota	2	.....	4	.....	2.25	.....	2.00	.....	110	.....	170	.....
Utah	2	.....	15	.....	3.50	.....	1.75	.....	275	.....	275	.....
Virginia	2	5	33	4	1.25	1.20	0.80	0.44	64	163	86	115
Other states (a)	2	8	45	1	2.50	1.99	1.46	0.50	267	220	213	100

STATES AND TERRITORIES.	BELOW GROUND.								
	Average number employed.			Average wages per day.			Average number of days worked.		
	Foremen.	Miners.	Laborers.	Foremen.	Miners.	Laborers.	Foremen.	Miners.	Laborers.
Total	11	67	97	$1.82	$1.44	$1.20	195	186	181
Colorado	.....	1	1	.....	2.50	2.50	.....	300	300
Iowa	.....	.....	.....	.....	.....	.....	.....	.....	.....
Kansas	3	8	16	2.00	1.31	1.38	204	187	285
Michigan	3	15	54	2.00	1.29	1.25	256	304	200
New York	.....	15	.....	.....	1.80	.....	.....	174	.....
South Dakota	.....	.....	.....	.....	.....	.....	.....	.....	.....
Utah	.....	.....	.....	.....	.....	.....	.....	.....	.....
Virginia	4	22	22	1.25	0.86	0.75	116	95	58
Other states (a)	1	6	4	3.00	3.00	2.00	300	240	150

a There are here grouped, in order that the business of individual establishments may not be disclosed to the public, California, Ohio, and Wyoming.

CAPITAL EMPLOYED IN GYPSUM PROPERTIES IN THE SEVERAL STATES AND TERRITORIES.

STATES AND TERRITORIES.	Total.	In land.	In buildings, machinery, etc.	Tools, implements, etc.	Cash.
Total	$2,473,175	$1,513,250	$540,610	$318,080	$101,235
Colorado	147,600	60,000	58,500	21,100	8,000
Iowa	194,500	78,500	45,000	69,500	1,500
Kansas	512,860	359,000	63,000	67,010	23,850
Michigan	725,000	347,000	276,000	81,000	21,000
New York	177,095	102,050	32,300	18,860	23,885
South Dakota	5,500	1,000	2,000	2,500	.....
Utah	150,000	100,000	30,000	20,000	.....
Virginia	300,620	249,000	13,510	16,110	22,000
Other states (a)	260,000	216,700	20,300	22,000	1,000

a There are here grouped, in order that the business of individual establishments may not be disclosed to the public, California, Ohio, and Wyoming.

CHARACTERISTICS OF THE INDUSTRY.

Taking the foregoing table of production, it will be noted that all the gypsum product of New York and Virginia has been sold either in a crude state or as land plaster. Although the returns show that 22,037 tons were sold crude, there are no evidences that it was used in any other way than as a fertilizer. The gypsum of New York state is intermingled intimately with slate, and for this reason is found to be more available for agricultural purposes than for calcination. It is understood that the gypsum of Virginia is adapted to the manufacture of plaster of paris, and the subject is being investigated with a view to operations if found profitable. It will be observed that while all of the gypsum produced in the eastern states is used as a fertilizer, nearly all of the western product, with the exception of that of Michigan and Iowa, is calcined. In Ohio, out of a total product of 9,920 short tons, 7,070

tons were made into plaster of paris. About 32 per cent of the Michigan and 34 per cent of the Iowa product was so disposed of, and practically all of the product of the other western states. During the present investigation inquiries were addressed to representative firms in different producing districts for the purpose of obtaining the percentage of loss in weight by the calcination of gypsum. In making land plaster there is practically no loss, the rock being ground in the condition as quarried. In no instances in the manufacture of land plaster has the loss amounted to more than 5 per cent, and even this was exceptional, the majority of producers reporting either no loss or a loss of from ½ to 1 per cent. In the calcining, loss percentages are reported in different producing districts as follows: Colorado, from 25 to 33.33 per cent; Iowa, from 21 to 30 per cent; Kansas, from 18 to 20 per cent; Michigan, from 20 to 25 per cent; Ohio, about 25 per cent; South Dakota, about 20 per cent; Wyoming, 22 per cent. No information was received in this respect from California or Utah. As the product of New York and Virginia is altogether consumed for land plaster, no losses are reported.

ANALYSES.

Below are given some analyses of gypsum and calcined plaster from New York, Michigan, and Ohio:

ANALYSES OF GYPSUM IN ONONDAGA COUNTY, NEW YORK.

	No. 1.	No. 2.
	PER CENT.	PER CENT.
Calcium sulphate	94.00	94.23
Carbonate of magnesia	3.00	2.65
Carbonate of lime	3.00	2.20
Oxide of iron		0.92
Total	100.00	100.00

ANALYSIS OF MICHIGAN LAND PLASTER.

	PER CENT.
Lime	32.35
Sulphuric acid	46.38
Water	19.70
Magnesia	0.54
Alumina	0.60
Insoluble residue	0.91
Total	100.48

ANALYSES OF CALCINED PLASTER FROM OHIO.

	No. 1.	No. 2.
	PER CENT.	PER CENT.
Lime	32.52	32.76
Sulphuric acid	45.56	46.20
Water	20.14	20.00
Magnesia	0.56	0.03
Alumina	0.16	0.29
Insoluble residue	0.68	0.46
Total	99.62	99.74

PRODUCTION IN PREVIOUS YEARS.

There is a very marked difference between the reports of the United States geological survey on the production of gypsum for years prior to 1889 and the figures obtained for the Eleventh Census. The tonnage for 1889 is largely in excess of that reported for previous years, but the value is, in comparison, greatly reduced. The product for 1888 was estimated at 110,000 short tons, at an average price of $5 per ton; that of 1889 was 267,769 tons, valued at $764,118, or an average of about $2.85 per ton. There was no report on the production of gypsum compiled in the Tenth Census, and there are no reliable figures after that time and previous to 1885. Since 1885 the product has been estimated for the Mineral Resources of the United States, as shown in the following table:

PRODUCTION OF GYPSUM IN THE UNITED STATES FROM 1885 TO 1888, INCLUSIVE.

YEARS.	Quantity. (Short tons.)	Value.
1885	90,405	$405,000
1886	95,250	428,625
1887	95,000	425,000
1888	110,000	550,000

LOCALITIES.

The gypsum-producing belt of New York lies along the southern shore of Lake Ontario, and includes the counties of Madison, Onondaga, Cayuga, Ontario, Monroe, and Genesee. The gypsum beds of Virginia are located in the southwest corner of the state along the North Fork of the Holston river, in Smyth and Washington counties. Transportation facilities are obtained by the Norfolk and Western railroad, which has a branch running to Saltville, Washington county, the most important producing point.

The production of gypsum in Ohio is confined to one locality, viz, the station of Gypsum, Ottawa county, on the line of the Lake Shore and Michigan Southern railroad, about 10 miles west of the city of Sandusky. The product of these quarries is of great excellence and purity. The best of the stone goes into calcined plaster, while any that is "off color" or streaked with shale is ground into land plaster.

The amount of each product and its value from 1881 to 1889 is shown in the following table:

PRODUCTION OF CALCINED AND LAND PLASTER SOLD IN OHIO FROM 1881 TO 1889, INCLUSIVE.

YEARS.	CALCINED PLASTER.			LAND PLASTER.		
	Barrels, of 300 pounds.	Average price per barrel.	Total value.	Short tons.	Average price per ton.	Total value.
1881	12,409	$1.55	$19,234	3,705	$4.35	$16,117
1882	16,888	1.46	24,656	4,404	4.33	19,069
1883	20,919	1.41	29,496	4,678	4.15	19,414
1884	20,307	1.38	28,024	4,217	4.09	17,248
1885	*a*8,686	1.31	11,379	4,038	4.03	16,273
1886	21,256	1.29	27,420	4,186	3.87	16,200
1887	21,981	1.28	28,136	4,098	3.87	15,859
1888	29,876	1.21	36,150	4,116	3.91	16,094
1889	41,675	1.00	41,675	*b*2,744	3.50	9,604

a Small production in 1885, due to rebuilding of the works.

b In addition to this there were 106 tons sold crude to fertilizer companies at $2 per ton.

The producing localities in Michigan continue the same as reported for previous years in the Mineral Resources of the United States, but the census returns show a decided increase in production over that of any previous year. The total product for the state of Michigan alone in 1889 was 131,767 short tons. The table following shows the production of land plaster and stucco in Michigan up to and including 1887. No report of the product of 1888 has been published.

AMOUNT OF LAND PLASTER AND STUCCO PRODUCED IN MICHIGAN.

YEARS.	Land plaster. (Short tons.)	Stucco. (Barrels, of 300 pounds.)
Previous to 1866	100,000	.....
1866	14,604	.....
1867	17,439	.....
Previous to 1868	.....	*a*80,000
1868	28,837	34,966
1869	29,996	41,187
1870	31,437	46,179
1871	41,126	48,685
1872	43,536	59,767
1873	44,972	82,453
1874	39,126	82,449
1875	27,019	61,129
1876	*a*39,131	64,386
1877	*a*40,000	*a*55,000
1878	40,000	48,346
1879	43,658	50,800
1880	49,570	106,004
1881	33,178	112,813
1882	37,821	135,165
1883	33,227	201,133
1884	27,888	156,677
1885	28,184	141,575
1886	29,378	153,274
1887	28,794	170,107

a Estimated.

The Iowa gypsum beds lie along the Des Moines river, in Webster county. All the operators have their headquarters at Fort Dodge, near which town the deposits are located.

The counties producing gypsum in Kansas are Saline, Barber, Marshall, Sedgwick, and Dickinson. There have been no previous reports on the production of gypsum in Kansas. The returns from the census inquiries show a total product for the year 1889 of 17,332 short tons, valued in its first merchantable condition at $94,235. All of the product was calcined and sold as plaster of paris or stucco.

The gypsum localities of South Dakota are in Lawrence county. Work was just begun on these mines in 1889, and the product was 320 tons, all of which was made into plaster of paris.

The producing point in California is in Santa Barbara county, near the town of Guadaloupe. The mineral produced here is of excellent quality and of a good white color. The beds are but a short distance from a steamboat landing, and the product is delivered in San Francisco or other ports along the coast at very little expense for transportation. Gypsum is found in a number of other places in California, notably in Nevada, Stanislaus, Kern, San Luis Obispo, San Diego, Monterey, Ventura, and Tulare counties. The Santa Barbara deposits, however, furnish the supply for the market.

In Colorado large deposits exist in the counties of Jefferson, Larimer, and El Paso. The beds that have so far been worked are in the neighborhood of Big Thompson, Larimer county, and Colorado Springs, El Paso county.

GYPSUM IMPORTED INTO THE UNITED STATES FROM 1867 TO 1889, INCLUSIVE.

YEARS ENDED—	Total.	GROUND OR CALCINED.		UNGROUND.		Value of manufactured plaster of paris.
		Quantity. (Long tons.)	Value.	Quantity. (Long tons.)	Value.	
June 30, 1867	$125,281	.....	$29,895	97,951	$95,386	.....
1868	114,350	.....	33,988	87,694	80,362	.....
1869	186,512	.....	52,238	137,039	133,430	$844
1870	148,720	.....	46,872	107,237	100,416	1,432
1871	154,013	.....	64,465	100,400	88,256	1,292
1872	168,873	.....	66,418	95,339	99,902	2,553
1873	165,459	.....	35,628	118,926	122,495	7,336
1874	170,901	.....	36,410	123,717	130,172	4,319
1875	171,096	.....	52,155	93,772	115,664	3,277
1876	179,070	.....	47,588	139,713	127,084	4,398
1877	162,917	.....	49,445	97,656	105,629	7,843
1878	140,587	.....	33,496	89,239	100,102	6,989
1879	125,542	.....	18,339	96,963	99,027	8,176
1880	150,409	.....	17,074	120,327	120,642	12,693
1881	171,724	.....	24,915	128,607	128,107	18,702
1882	200,922	5,737	53,478	128,382	127,067	20,377
1883	218,969	4,291	44,118	157,851	152,982	a21,869
1884	210,904	4,996	42,904	166,310	168,000	.....
1885	173,752	6,418	54,208	117,161	119,544	.....
1886	153,338	5,911	37,642	122,270	115,696	.....
1887	195,890	4,814	33,736	146,708	162,154	.....
Dec. 31, 1888	190,787	3,340	20,764	156,697	170,023	.....
1889	220,140	5,466	40,291	170,965	179,849	.....

a Not specified since 1883.

INFUSORIAL EARTH.

INFUSORIAL EARTH.

BY E. W. PARKER.

PRODUCTION.

Infusorial earth has been found in useful quantity in a number of places in California, Connecticut, Maryland, Nevada, New Hampshire, New Jersey, New Mexico, Oregon, and Virginia, but the production in 1889 was limited to 5 states, namely, California, Connecticut, Maryland, New Hampshire, and New Jersey. The bulk of the product was obtained from the Dunkirk district, in Maryland, the ledge at Dunkirk producing 3,000 short tons and all other localities 466 short tons. An excellent deposit of infusorial earth was opened at Popes Creek, Maryland, in 1887, and a considerable quantity taken out, but owing to a slack demand only 50 tons were produced at this point in 1889. In Storey county, Nevada, there is a mine of a fine quality of infusorial earth, but no work was done upon it in the census year. The following table shows the production of infusorial earth in 1889, by states:

PRODUCTION OF INFUSORIAL EARTH IN 1889, BY STATES.

STATES.	Amount. (Short tons.)	Value.
Total	3,466	$23,372
California (*a*)	50	8,000
Connecticut (*b*)	211	422
Maryland (*b*)	3,050	10,700
New Hampshire (*a*)	80	2,750
New Jersey (*a*)	75	1,500

a Separated and ground. *b* Crude at the mines.

LABOR AND WAGES.

The mines at Dunkirk, Maryland, were the only ones which were operated actively during the year. The work at the other producing localities was irregular and of short duration. In protection of individual interests the statistics pertaining to labor, wages, and capital for the entire United States are grouped.

LABOR AND WAGES.

DISTRIBUTION.	Average number employed.	Average wages per day.	Average number of days worked.
Total	52		
Foremen	3	$2.83	93
Mechanics	4	2.50	145
Laborers	45	1.30	107

OPERATING EXPENSES.

Wages	$8,388
Paid contractors	575
Paid for supplies	760
Paid for other expenditures (rent, insurance, taxes, etc.)	6,955
Total	16,678

CAPITAL INVESTED.

In land	$61,380
In buildings, machinery, etc	21,900
In tools, implements, live stock, etc	16,970
In cash	10,500
Total	110,750

USES.

Infusorial earth is used to a considerable extent in the manufacture of various cleansing preparations, either in the form of powder or soap. The greater portion of the product of this country is dried in furnaces at the pits and used for making protective coating for boilers. Some infusorial earth has been imported from Germany and used as an absorbent in the manufacture of dynamite from nitroglycerin. The American product, however, does not possess sufficient absorbent properties for this purpose, and the German product has been supplanted by the use of wood pulp, which answers the purpose excellently and is much cheaper. The first development of infusorial earth properties in California was made in 1889. This was due to the discovery of a valuable ledge near Calistoga, Napa county. By practical tests it was learned that the mineral was excellently adapted for use as a polishing powder, and a number of ladies organized a stock company for the purpose of mining and manufacturing the mineral. The property was considerably developed during 1889, and indications pointed to extensive operations in the near future.

The following table shows the analyses of infusorial earths from various localities:

ANALYSES OF INFUSORIAL EARTHS FROM VARIOUS LOCALITIES.

INGREDIENTS.	From Popes Creek, Maryland. (*a*) (Per cent.)	From Morris county, New Jersey. (Per cent.)	From near Richmond, Virginia. (*b*) (Per cent.)	From Storey county, Nevada. (*c*) (Per cent.)
Total	100.00	99.09	98.95	100.60
Moisture	3.47	.....	8.37	.....
Silica	81.53	80.66	75.86	81.08
Alumina	3.43	3.84	9.88	.....
Protoxide of iron	3.33	.....	.....	.....
Lime	2.61	0.58	0.29	.....
Ferric oxide	.....	.....	2.92	.....
Magnesia, soda, potash, sulphur, and organic matter	5.63	.....	1.63	.....
Loss on ignition	.....	14.01	.....	.....
Water at red heat	.....	.....	.....	18.44
Loss	.....	.....	.....	0.48

a Made by Mr. P. de P. Ricketts, of New York. *b* Made by Mr. J. M. Cabell. *c* Made by Mr. W. Habirshaw.

CORUNDUM.

CORUNDUM.

BY E. W. PARKER.

OCCURRENCE.

Corundum and emery are distinguished from each other in that the former is simply the oxide of aluminum found native, while emery is oxide of aluminum mixed with oxide of iron. Emery is not found in any workable quantity in the United States, while corundum is found to a considerable extent in the eastern states. The principal localities are Chester, Massachusetts; Macon and Clay counties, North Carolina, and Rabun county, Georgia. Small quantities have been produced in Westchester county, New York, and Delaware county, Pennsylvania.

PRODUCTION.

The amount of corundum produced in the United States in 1889 was 2,245 short tons, valued at the mines at $105,565. The entire industry is controlled by 3 or 4 firms, and in order to protect private interests it is deemed best not to publish the figures by states.

LABOR AND WAGES.

The following table shows the number of men employed at corundum mines in the United States in 1889, the average wages paid each class per day, and the number of days worked:

LABOR EMPLOYED AT CORUNDUM MINES IN 1889.

DISTRIBUTION.	Average number employed.	Average wages per day.	Average number of days worked.
Total	129	.....	.....
Above ground:			
Foremen	5	$2.63	269
Mechanics	5	1.40	266
Laborers	45	1.12	253
Below ground:			
Foremen	2	1.87	299
Miners	66	1.30	292
Laborers	6	1.17	217

OPERATING EXPENSES IN PRODUCING CORUNDUM.

Wages, including office force at mines	$44,660
Paid contractors	600
Paid for supplies	9,382
Other expenditures	2,462
Total	57,105

CAPITAL INVESTED.

In land	$21,600
In buildings, machinery, etc	11,100
In tools, implements, etc	28,200
Cash	12,500
Total	73,400

PRODUCTION IN PREVIOUS YEARS.

A considerable increase is noted in the production of corundum by comparing the figures for 1889 with those for 1880. The following table is given for comparison:

COMPARATIVE STATISTICS OF CORUNDUM PRODUCTION FOR 1889 AND 1880.

YEARS.	Quantity. (Short tons.)	Value.
1889	2,245	$105,565
1880	1,044	29,280
Increase	1,201	76,285

The estimates of the production for the intermediate years, as published in the Mineral Resources of the United States, cover only the product of the mines in North Carolina and Georgia, and the values are given for the mineral in a more advanced stage of preparation for market; hence they are of little value for comparative statistics, as shown in the following table:

ESTIMATED PRODUCTION OF CORUNDUM FOR THE YEARS 1881 TO 1888, INCLUSIVE.

YEARS.	Quantity. (Short tons.)	Value.
1881	560	$80,000
1882	500	80,000
1883	550	100,000
1884	600	108,000
1885	600	108,000
1886	645	116,190
1887	600	108,000
1888	589	91,620

IMPORTS.

All corundum consumed in the United States is of domestic production. The emery used is imported, coming principally from Asia Minor.

The following table shows the imports of emery from 1867 to 1889, inclusive:

EMERY IMPORTED INTO THE UNITED STATES FROM 1867 TO 1889, INCLUSIVE.

YEARS ENDED—	Total value.	GRAINS.		ORE OR ROCK.		PULVERIZED OR GROUND.		Other manufactures.
		Quantity. (Pounds.)	Value.	Quantity. (Tons.)	Value.	Quantity. (Pounds.)	Value.	
June 30, 1867	$52,504	.....	.....	423	$14,373	924,431	$38,131	.....
1868	38,080	.....	.....	85	4,531	834,286	33,549	.....
1869	77,916	.....	.....	964	35,205	924,161	42,711	.....
1870	54,866	.....	.....	742	25,335	644,080	29,531	.....
1871	44,811	.....	.....	615	15,870	613,624	28,941	.....
1872	77,424	.....	.....	1,641	41,321	804,977	36,103	.....
1873	70,919	610,117	$29,706	755	26,065	343,828	15,041	$107
1874	62,366	331,580	16,216	1,281	43,886	69,890	2,167	97
1875	58,327	487,725	23,345	961	31,972	85,853	2,990	20
1876	61,653	385,246	18,999	1,395	40,627	77,382	2,533	94
1877	42,182	343,697	16,615	852	21,964	96,351	3,603	.....
1878	56,691	334,201	16,359	1,475	38,454	65,068	1,754	34
1879	87,506	496,633	24,456	2,478	58,065	133,556	4,985	.....
1880	105,894	411,340	20,066	3,400	76,481	223,855	9,202	145
1881	97,432	454,790	22,101	2,884	67,781	177,174	7,497	53
1882	98,695	520,214	25,314	2,765	69,432	117,008	3,708	241
1883	85,490	474,105	22,767	2,447	59,282	93,010	3,172	269
1884	148,893	143,267	5,802	4,145	121,719	513,161	21,181	188
1885	74,800	228,329	9,886	2,445	55,368	194,314	8,789	757
Dec. 31, 1886	121,638	161,297	6,910	5,782	88,925	365,947	24,952	851
1887	68,209	367,239	14,290	2,078	45,033	a144,380	6,796	2,090
1888	118,246	430,397	16,216	5,175	93,287	.....	.....	8,743
1889	218,966	503,347	18,937	5,294	88,727	.....	.....	111,302

a To June 30 only; since classed with grains.

MILLSTONES.

MILLSTONES.

BY E. W. PARKER.

PRODUCTION.

The total value of millstones produced in 1889 was $35,155. The estimated value of the entire product for 1888 was $81,000, showing a decrease of about 57 per cent. While it is true that the demand for domestic millstones is steadily decreasing, it must be taken into consideration that the values of the product for 1888 and previous years were estimated and probably considerably exaggerated, owing to the prevalent desire of operators to make a favorable showing for their particular localities, and possibly, also, to a duplication of returns. It must also be remembered that the census report covers only those engaged in the quarrying and cutting of domestic stone. Manufacturers of millstones from French buhr or dealers in imported buhrstones are not included in this report, except by such reference as may be made to imports.

LOCALITIES.

The flint and quartz conglomerate from which millstones are made is found at different places along the Allegheny mountains. In Ulster county, New York, it is quarried under the name of "Esopus stone"; in Lancaster county, Pennsylvania, it is known as "Cocalico stone"; in Montgomery county, Virginia, it is called "Brush Mountain stone", and in Moore county, North Carolina, it is termed "North Carolina grit".

The following table shows the estimated values of the product of the different regions from 1883 to 1888, inclusive, and the value of the product for 1889:

VALUE OF MILLSTONES PRODUCED IN THE UNITED STATES FROM 1883 TO 1889, INCLUSIVE.

KINDS.	1883.	1884.	1885.	1886.	1887.	1888.	1889.
Total	$150,000	$150,000	$100,000	$140,000	$100,000	$81,000	$35,155
Esopus stone	120,000	110,000	90,000	100,000	75,000	60,000	23,377
Cocalico stone	30,000	40,000	10,000	10,000	5,000	1,000	5,800
Brush Mountain stone (a)							5,978
North Carolina grit (b)				30,000	20,000	20,000	

a No figures have been published previous to 1889.

b No figures have been published previous to 1886, and the quarries were abandoned in 1889. A few stones were made in the latter year from material previously quarried, but no work was done at the quarries.

LABOR AND WAGES.

The quarrying and cutting of millstones is a very irregular industry, those engaged in it operating only upon orders. As a rule, no record of any kind is kept, and each cutter is as much as possible an independent operator. He receives an order for a stone, repairs to the mountain, finds a slab from which the desired size may be readily obtained, and then employs what help he needs to cut the stone and haul it to the nearest railroad station. The figures given in the following table cover the industry for the United States, and are partly estimates, based upon statements of the larger operators, the men making about half time during the year:

EMPLOYÉS.

CLASSIFICATION.	Average number employed.	Average wages per day.
Total	98	
Foremen	3	$3.00
Cutters	42	2.00
Laborers	51	1.16
Boys under 16 years of age	2	1.00

EXPENDITURES.

The following statement shows the total amount of wages paid during 1889, the amount paid contractors, the value of supplies consumed, and other expenses connected with the quarrying and cutting of millstones:

OPERATING EXPENSES IN PRODUCING MILLSTONES.

Paid for wages	$17,853
Paid contractors	1,193
Paid for supplies	1,413
Paid for royalty	540
Other expenditures (including rent, taxes, insurance, interest, etc.)	385
Total	21,384

CAPITAL.

In compiling the returns relative to capital it is necessary to estimate a large portion of the amount invested in land. This estimate is based on the royalty paid by operators for the stone taken out. The royalty is usually paid at a fixed rate per pair.

CAPITAL EMPLOYED.

In land	$29,270
In buildings, machinery, etc	3,300
In tools, implements, live stock, etc	16,375
In cash (not reported in foregoing items)	6,000
Total	54,945

The decrease in the demand for millstones is due in most part to the introduction of the roller process for grinding cereals. Grinders of paints, cement rock, gypsum, etc., continue to use domestic stones, and for these purposes the form known as "chasers" is usually employed. Proprietors of flouring mills who have not adopted the roller process prefer stones made from French buhr, a quality of stone which has not yet been found in the United States.

VALUE OF BUHRSTONES AND MILLSTONES IMPORTED INTO THE UNITED STATES FROM 1868 TO 1889.

YEARS ENDED—	Total.	Rough.	Made into millstones.
June 30, 1868	$74,224	$74,224	.....
1869	60,361	57,942	$2,419
1870	60,898	58,601	2,297
1871	39,104	35,406	3,698
1872	75,029	69,062	5,967
1873	68,578	60,463	8,115
1874	79,710	36,540	43,170
1875	115,059	48,068	66,991
1876	84,087	37,759	46,328
1877	83,925	60,857	23,068
1878	89,607	87,679	1,928
1879	106,572	101,484	5,088
1880	125,072	120,441	4,631
1881	103,912	100,417	3,495
1882	104,034	103,287	747
1883	73,685	73,413	272
1884	46,100	45,837	263
1885	35,477	35,022	455
Dec. 31, 1886	29,935	29,273	662
1887	24,007	23,816	191
1888	37,228	36,523	705
1889	40,884	40,432	452

WHETSTONES.

WHETSTONES.

BY E. W. PARKER.

VARIETIES AND OCCURRENCE.

The sources of supply of siliceous rock in the United States used for sharpening edged tools have been the same for some years. Arkansas, Indiana, and New Hampshire furnish the bulk of the supply, and a small quantity is produced in Vermont. The Arkansas stone is found in the neighborhood of Hot Springs, and is supposed to have been formed by the action of hot water upon the quartz formations. It is found in 2 varieties, known as Arkansas and Washita stone, the grains in the former being smaller and more compact, of a uniform bluish-white color, and semitransparent, while the Washita stone is more opaque and of a pure white color. In Indiana 2 varieties also occur, known commercially as Hindostan and Orange stone, the former being white in color and the latter of a buff or orange tint. The quarries are all located in Orange county. The quarries in New Hampshire are located in Grafton county, and the product consists of rift sandstone and chocolate whetstone. The Vermont quarries are located in Orleans county, and the product is used exclusively for scythestones. Some Labrador oilstones have in the past been produced at Manlius, Onondaga county, New York, but the factory is now used for the manufacture of oilstones from Arkansas and Washita stone.

PRODUCTION.

The product of the different kinds of sharpening stones in 1889 consisted of 456 tons of scythestone, 1,500 tons of rift sandstone, 30,000 pounds of orange stone, 1,036,000 pounds of Washita oilstone, 175,000 pounds of Arkansas oilstone, and 200,179 pounds of Hindostan oilstone. The production, by states, is shown in the following table, and for the sake of convenience the quantity is expressed in short tons, the weight and value given being for rough stone:

PRODUCTION OF SHARPENING STONES IN THE UNITED STATES FOR 1889, BY STATES.

[Short tons.]

STATES.	Quantity.	Value.
Total	2,991	$52,980
Arkansas	814	20,360
Indiana	212	7,670
New Hampshire	1,515	3,750
Vermont	450	1,200

LABOR EMPLOYED IN PRODUCING WHETSTONES.

STATES.	AVERAGE NUMBER EMPLOYED.				AVERAGE WAGES PAID.				AVERAGE NUMBER OF DAYS WORKED.			
	Foremen.	Mechanics.	Laborers.	Boys under 16 years.	Foremen.	Mechanics.	Laborers.	Boys under 16 years.	Foremen.	Mechanics.	Laborers.	Boys under 16 years.
Total	13	1	68	9	$2.08	$1.50	$1.27	$0.72	187	130	189	182
Arkansas	6	.....	32	.....	2.33	.....	1.50	.....	178	.....	177	.....
Indiana	4	.....	a22	8	1.25	.....	0.86	0.75	225	.....	249	200
New Hampshire	2	1	9	1	3.00	1.50	1.47	0.50	179	130	134	35
Vermont	1	.....	5	.....	2.00	.....	1.25	.....	100	.....	100	.....

a Includes 2 miners and 1 laborer underground.

OPERATING EXPENSES IN PRODUCING WHETSTONES.

STATES.	Total expenditures.	Wages.	Paid contractors.	Paid for supplies.	Other expenditures.
Total	$23,894	$21,911	$800	$833	$255
Arkansas	11,875	11,060	800	.....	15
Indiana	7,148	6,763	.....	235	150
New Hampshire and Vermont (a)	4,781	4,088	.....	633	90

a These 2 states are combined in order that the business of individual establishments may not be disclosed to the public.

CAPITAL INVESTED.

STATES.	Total.	In land.	In buildings, machinery, etc.	In tools, implements, live stock, etc.	In cash.
Total	$57,510	$42,500	$4,925	$6,885	$4,200
Arkansas	20,825	18,000	625	700	1,500
Indiana	9,225	4,700	700	1,825	2,000
New Hampshire and Vermont (a)	27,460	19,800	2,600	4,360	700

a These 2 states are combined in order that the business of individual establishments may not be disclosed to the public.

EXPORTS AND IMPORTS.

Considerable quantities of whetstone and scythestone are exported from the United States, but the material is classed with marble, limestone, etc., and there is no way of ascertaining the quantities or values of each. The imports consist of manufactured whetstones and razor hones, and are shown in the following table:

IMPORTS OF WHETSTONES AND RAZOR HONES FOR THE YEARS 1880 TO 1889, INCLUSIVE.

Years ended—	
June 30, 1880	$14,185
1881	16,651
1882	27,882
1883	30,178
1884	26,513
1885	21,434
Dec. 31, 1886	21,141
1887	24,093
1888	30,676
1889	27,400

MICA.

MICA

BY L. J. CHILDS.

GENERAL REVIEW OF THE INDUSTRY.

The production of cut mica in the United States in the census year amounted to 49,500 pounds, valued at $50,000. In addition to this, 196 short tons of scrap or waste mica were sold for grinding purposes, with a value of $2,450. The production in 1880, as given in the Tenth Census report, was 81,669 pounds of cut mica, valued at $127,825.

A review of the annual production during the past 9 years shows that the industry advanced in importance until 1885. Since then the tendency has been downward, though the fluctuations in the production of the different regions have caused much irregularity in the annual totals. The following table does not include statistics of scrap and waste mica, as there had been no attempt prior to 1889 to determine the amount of this waste which has been utilized:

CUT MICA PRODUCED IN THE UNITED STATES.

YEARS.	Amount. (Pounds.)	Value.
1880	81,669	$127,825
1881	100,000	250,000
1882	100,000	250,000
1883	114,000	285,000
1884	147,410	368,525
1885	92,000	161,000
1886	40,000	70,000
1887	70,000	142,250
1888	48,000	70,000
1889	49,500	59,000

During the years 1883 and 1884, when mica mining was in its most flourishing condition, the manufacturers of stoves consumed probably 95 per cent of the product, and the fancy grades and large sizes of sheet mica which were then used found a ready sale at highly profitable prices. Under this stimulus of large profits many surface deposits or pockets were opened by farmers or other individuals of small means, who worked them occasionally when other business was dull and realized a considerable profit on their production. As long as the demand for large sizes continued this intermittent sort of mining could be carried on with a degree of success, but when the fashion in stove panels changed and small sheets were used in place of the large ones, the demand for the latter fell off to a great extent. Mica suitable for cutting into large sheets was much less abundant than that available for small sizes; therefore lower rates had always prevailed for the latter, and careful, steady, and systematic methods were necessary to produce such grades profitably. When the demand changed from large to small sizes the majority of miners were unprepared, through lack of capital or for other reasons, to adopt such methods. The result was a great reduction in the number of producing mines, and consumers were compelled either to raise the price of mica or look to foreign sources for their supply. Another factor in increasing importation came into existence with the extended manufacture of dynamos and other electrical apparatus, in which a great deal of mica is used. The foreign article, especially that produced in Canada, was, on account of its superior cleavage, preferred to the domestic for this purpose, but since miners have become more fully acquainted with the qualities desired for electrical uses it has been proved that the United States can produce mica for this purpose equal to any found abroad. The foreign supply, after gaining a foothold in American markets, has more than held its own, and as its tendency has always been toward a reduction in prices there has been little inducement for the outlay of capital in mica mining.

Only a small number of mines were operated in 1889, and few of these were worked steadily throughout the year. However, there was a fair amount of development work done in the different mica regions, and it is expected that the introduction of more systematic methods of mining will greatly increase the importance of the industry.

OCCURRENCE.

Mica is one of the natural constituents of a number of the more common rocks, and as such it is widely distributed throughout the United States, but the localities in which it occurs in an available form are not very numerous. While deposits have been noted in nearly all of the states on the eastern border of the Appalachian mountain system, it is only in New Hampshire and North Carolina that the industry has assumed at any time much importance. In the west the most important deposits are located in the Black Hills, in the neighborhood of Harteville, Wyoming, and in the Cribbensville district of New Mexico.

The available deposits of mica occur in bands of coarsely crystalline granite. In these bands the 3 constituents of the granite (mica, feldspar, and quartz) have in a measure crystallized in separate masses, and the mica is found in bunches or pockets irregularly distributed throughout the mass. The deposits are of great interest aside from their commercial importance on account of the number of rare minerals which are nearly always present. Among these are beryl, tourmaline, garnet, columbite, and samarskite. In some cases one or more of these minerals are present in sufficient quantity and of such fine quality as to give value to the deposit. Some of the finest tourmalines in the world have been found at Mount Mica, near the town of Paris, Maine, in the mica deposit at that place. Tin ore is also an accompaniment of the mica deposits in the Black Hills region.

TREATMENT OF THE CRUDE PRODUCT.

Mica is used in two forms, sheet mica and ground mica, and the manner in which it is treated when taken from the mine depends upon the form in which it is to be used. If it is to be sold as scrap for grinding, all that is necessary is to remove the adhering fragments of quartz and feldspar and such parts of the mica as may contain foreign ingredients. If it is to be used in sheet form, the process is much more complicated, the blocks being first split into sheets thin enough to cut easily, then marked with a pattern of the size desired, cut along the lines marked, and the different sizes wrapped in paper and packed for shipment. There is a great amount of waste about this operation. The amount of sheet mica obtained does not usually exceed from 4 to 8 per cent of the block mica treated.

USES.

The most common and well-known use for mica is in the paneling of stove and furnace doors. For this purpose the mica must be clear, free from spots, and of a uniform color throughout the sheet. The most desirable color is a wine red, and next to this comes white mica, which is nearly as valuable. Another important use is in the manufacture of electrical apparatuses, for which purpose its nonconducting properties render it valuable. The qualities required for this use are firmness of texture, toughness, and ready cleavage.

There is a greater range of use for ground mica than for the mineral in sheets, and though the value of that part of the product made use of in this form is small, the many peculiar properties which ground mica possesses render it quite probable that its use will be widely extended. The difficulties to be overcome in grinding mica are considerable, and there are only 2 or 3 firms engaged in the business at present. 8 standard grades of ground mica are made. The coarsest of these are used to give frosted and spangled effects to the fancy grades of wall paper. The medium grades are employed in the manufacture of a lubricant for the journals of railway carriages, for heavy bearings generally, and for the axles of road vehicles. The finest grades are used in producing a uniform metallic white surface on wall paper. Scrap mica for grinding must be white and as free from specks or colored matter as possible, since any impurities in the scrap will affect the color and luster of the product.

PRODUCTION.

Much trouble has been experienced in collecting statistics of production and other data owing to the general lack of systematic records among the miners, and the figures furnished by them for the Census Office were for the most part estimates. The greater part of the product in 1889 was taken from 1 mine in New Hampshire. Of the North Carolina mines none were in steady operation throughout the year, and the production of that state was the result of irregular and spasmodic efforts. In Virginia the production was confined to 1 mine, located at Amelia Court House, which was exhausted early in the year. In the Black Hills region, where, in 1884, 11 mines were operated, with a production of over 18,000 pounds of mica, only 1 produced in 1889, and that only a small amount. In New Mexico a good deal of developing work was done and a quantity of good mica was reported as taken out; but as none of this was marketed, it has not been included in the totals for 1889. In the following table the production of Virginia and South Dakota is included under one head, that the operations of private individuals may not be disclosed.

PRODUCTION AND VALUE OF MICA IN THE UNITED STATES IN 1889, BY STATES.

STATES.	CUT.		SCRAP.	
	Pounds.	Value.	Short tons.	Value.
Total	49,500	$50,000	196	$2,450
New Hampshire	40,000	40,000	160	2,000
North Carolina	6,700	7,000	.....	.....
Virginia and South Dakota	2,800	3,000	36	450

EXPENDITURES.

The laws relating to mining claims in the western states require that work to the extent of not less than $100 per year shall be expended on each claim. The amount involved in this assessment work, together with that expended in the development of mines at which no mica was produced in 1889, amounted to $12,910, and this sum has been included in the following table of expenditures.

EXPENDITURES AT MICA MINES IN THE UNITED STATES IN 1889, BY STATES AND TERRITORIES.

STATES AND TERRITORIES.	Total.	Wages.	Supplies.	Other expenses.
Total	$58,335	$42,174	$7,408	$8,753
New Hampshire	38,635	28,330	5,305	5,000
North Carolina	12,722	7,266	1,703	3,753
New Mexico	2,250	2,050	200	.....
Other states (*a*)	4,728	4,528	200	.....

a Including Virginia, Massachusetts, South Dakota, Wyoming, and Idaho.

LABOR AND WAGES.

The men employed at mica mines in 1889 numbered 185 and drew wages to the amount of $42,174, but of this number only a small proportion were steadily employed throughout the year. The scale of wages in force in the mines in different sections of the country shows a wide range in the amounts paid for the same class of work in different localities. The following table gives the number of men of each class employed in each state, with the average wages per day and the average number of days worked:

MEN EMPLOYED AND WAGES PAID AT MICA MINES IN THE UNITED STATES IN 1889, BY STATES AND TERRITORIES.

STATES AND TERRITORIES.	FOREMEN.			MECHANICS.			MINERS.			LABORERS.		
	Number employed.	Average wages per day.	Average number of days worked.	Number employed.	Average wages per day.	Average number of days worked.	Number employed.	Average wages per day.	Average number of days worked.	Number employed.	Average wages per day.	Average number of days worked.
New Hampshire	*a*6	$2.75	300	7	$1.50	300	24	$1.50	250	33	$1.50	250
North Carolina	4	1.10	110	.....	.....	.....	34	0.75	110	25	0.75	75
Virginia	3	1.75	100	.....	.....	.....	16	0.75	100	7	1.10	80
South Dakota	1	3.00	60	.....	.....	.....	.....	.....	.....	2	3.00	60
New Mexico	1	2.00	100	.....	.....	.....	10	2.00	75	1	1.00	15
Massachusetts	.....	.....	.....	.....	.....	.....	4	1.50	180	.....	.....	.....
Wyoming	.....	.....	.....	.....	.....	.....	4	2.50	50	.....	.....	.....
Idaho	.....	.....	.....	.....	.....	.....	3	2.00	17	.....	.....	.....

a Including office force.

CAPITAL INVESTED.

The total amount invested in the mica-mining industry in the United States in 1889 is given at $691,550. The North Carolina region contains a majority of the mines of the country, but most of these are small and little improved in the way of buildings and machinery. Those of New Hampshire are much better fitted in this respect for steady and systematic mining, and this fact accounts, in part at least, for the larger production of that state. The following table gives the capital invested by states:

CAPITAL INVESTED IN MICA MINES IN THE UNITED STATES IN 1889, BY STATES AND TERRITORIES.

STATES AND TERRITORIES.	Total.	Land.	Buildings, etc.	Tools, etc.	Cash.
Total	$691,550	$636,560	$28,340	$21,250	$5,400
North Carolina	438,475	420,710	6,090	8,675	3,000
New Hampshire	194,750	160,350	20,350	11,650	2,400
Georgia	21,500	21,250	200	50	.....
New Mexico	14,700	13,400	950	350	.....
South Dakota	13,300	13,000	200	100	.....
South Carolina	4,600	4,600	.....	.....	.....
New York	2,000	1,300	500	200	.....
Idaho	1,000	925	50	25	.....
Other states (a)	1,225	1,025	.....	200	.....

a Including Massachusetts, Pennsylvania, and Wyoming.

UNMANUFACTURED MICA IMPORTED INTO THE UNITED STATES.

Years ended—		Years ended—	
June 30, 1869	$1,165	June 30, 1880	$12,562
1870	226	1881	5,839
1871	1,460	1882	5,175
1872	1,002	1883	9,884
1873	498	1884	28,284
1874	1,204	1885	28,685
1875	.....	Dec. 31, 1886	56,354
1876	569	1887	49,085
1877	13,085	1888	57,541
1878	7,930	1889	97,351
1879	9,274		

ASBESTOS.

ASBESTOS.

BY E. W. PARKER.

VARIETIES.

The fibrous material known to the trade under the name of asbestos comprises at least two distinct species of minerals, one of which, a variety of hornblende, is properly called asbestos; the other is chrysotile, a variety of serpentine, and may be readily distinguished from asbestos by yielding water when heated in a closed tube. Both asbestos and chrysotile are found in regions of altered crystalline rocks, and yet each has its own particular associates. The former occurs with metamorphic rocks rich in hornblende, while the latter is found in distinct veins penetrating masses of serpentine, which have resulted generally from the alteration of eruptive rocks rich in olivine. It is customary, however, in trade circles to include both varieties under the name of asbestos, and they are so treated in this report.

Asbestos is found in the United States in a comparatively narrow belt of metamorphic rocks, extending along the Piedmont region or eastern slope of the Appalachian mountains, from New York, through Pennsylvania, Maryland, Virginia, North Carolina, and South Carolina, into Georgia. It is inferior in quality to the best that is mined in Italy or Canada. Its fibers are comparatively short and somewhat spindle-shaped, with occasional cross fractures, which not only render it brittle but diminish its tensile strength. Asbestos is also found in considerable quantities in California and Wyoming, but this also lacks the essential quality of strength of fiber.

The asbestos of Canada properly belongs to the chrysotile variety. It is found in the Thetford region, and is now being extensively mined. It occurs in serpentine in irregular veins varying in thickness from a mere film to 6 inches. The fibers extend directly across the vein, are long and even as well as flexible, slightly elastic, and of great tensile strength.

PRODUCTION.

The production of asbestos in the United States has shown an annual decrease since 1882. The product for 1882 was 1,200 short tons; 1883, 1,000 short tons, and 1884, 1,000 short tons. The product for 1885 showed a decided drop, being only 300 short tons, and this was again reduced to 200 short tons in 1886 and 150 short tons in 1887. In 1888 the product was 100 short tons, valued at $30 per ton. In 1889 the only asbestos mined in this country and marketed came from California, amounting to 30 tons, valued at $1,800. A trifling amount of asbestos, about 300 pounds, was taken out and saved as a by-product in quarrying soapstone in Pennsylvania and sold locally to druggists and chemists at an average price of 9 cents per pound. This small factor has been omitted from the total.

There was a considerable amount of development work done on asbestos mines in Wyoming, but the product was not placed upon the market. These mines are situated about 22 miles from Rock Creek, on the Union Pacific railroad. The veins and pockets are said to be numerous, extending in all directions, and vary in width from a few inches to over 4 feet. Some of the fibers are reported to be over 40 inches in length, but that so far obtained is somewhat brittle, though improving in quality as greater depth is reached.

EXPENDITURES.

In the statement following, showing the amount of money paid for wages, etc., there is included the sum of $1,900, which was expended in development work at mines in Wyoming. The statement of capital also includes that invested in Wyoming properties.

OPERATING EXPENSES IN PRODUCING ASBESTOS.

Wages	$2,700
Supplies consumed	525
Total	3,225

CAPITAL INVESTED.

In land	$41,500
In buildings, machinery, etc	600
In tools, implements, live stock, etc	500
Total	42,600

NOTE.—Acknowledgments are due Professor J. S. Diller, of the United States geological survey, for valuable information regarding the varieties and occurrence of asbestos.

LABOR AND WAGES.

The following table shows the number of men employed, the average wages paid per day, and the average number of days worked by each class:

EMPLOYÉS AT ASBESTOS MINES IN THE UNITED STATES IN 1889.

DISTRIBUTION.	Average number employed.	Average wages per day.	Average number of days worked.
Total	12	.....	.....
Above ground:			
Foremen	1	$2.75	75
Laborers	7	2.00	75
Office force at mines	1	.....	.....
Below ground:			
Foremen	1	5.00	150
Miners	2	2.50	150

USES.

Asbestos is used in the manufacture of fireproof paints, roofing, piston packing, felt packing, fireproof cements, sheet and roll millboards, flooring, and for a covering for steam pipes and boilers. It is largely used in lining for fireproof safes, and is also made into yarn, cloth, and paper. Nonconsuming lampwicks and fireproof drop curtains for theaters are now being made of this material. Some demand has also been created for its use in the manufacture of insulators for electric wires. The fiber of the American asbestos is more brittle and harsh than the imported, and not so well adapted to the manufacture of spun and woven goods. It is said, however, to stand a greater degree of heat than the Canadian or foreign material, and is more suitable for the manufacture of fireproof cement and paint, for which the length of fiber is not essential. If the conditions were such that the mineral could be economically mined in this country, it is probable that a considerable amount of capital would be invested in the industry.

IMPORTS.

The following table shows the value of asbestos imported and entered for consumption in the United States for the years 1869 to 1889, inclusive:

ASBESTOS IMPORTED FROM 1869 TO 1889.

YEARS ENDED—	Total.	Unmanufactured.	Manufactured.
June 30, 1869	$310	.....	$310
1870	7	.....	7
1871	12	.....	12
1872	.....	.....	.....
1873	18	$18	.....
1874	152	152	.....
1875	5,783	4,706	1,077
1876	5,881	5,485	396
1877	3,221	1,671	1,550
1878	3,908	3,536	372
1879	7,828	3,204	4,624
1880	9,736	9,736	.....
1881	27,786	27,717	69
1882	15,739	15,235	504
1883	24,612	24,369	243
1884	49,940	48,755	1,185
Dec. 31, 1885	73,643	73,026	617
1886	135,125	134,193	932
1887	140,845	140,264	581
1888	176,710	168,584	8,126
1889	263,393	254,239	9,154

The imports of crude asbestos for 1889 were greatly in excess of those for any previous years, being about 51 per cent over those for 1888, 81 per cent over 1887, and 89 per cent over 1886, and exceeding the entire imports from 1869 to 1885, inclusive.

GRAPHITE.

GRAPHITE.

BY E. W. PARKER.

PRODUCTION.

The production of graphite in the United States in 1889 amounted to 7,003 short tons of crude ore. This is partly estimated, as in several instances operators kept no record of the product from the mines, and could only make returns for the quantity of refined graphite obtained, with the value. In such instances the amount of crude product is estimated according to the average per cent of yield of refined graphite per ton of ore. A considerable portion of the graphite produced in 1889 was used in the crude state. The amount of refined graphite obtained has averaged about 400,000 pounds each year during the past decade. It will be observed that in Pennsylvania and Michigan the expenditures are in excess of the value of the product. This fact is due to the large expense incurred in developing some of the graphite properties. These mines show promise of paying activity in the near future.

PRODUCTION OF CRUDE GRAPHITE IN 1889, BY STATES AND TERRITORIES.

STATES AND TERRITORIES.	Crude ore. (Short tons.)	Value.	Total expenses.	Total wages paid.	Paid contractors.	Paid for supplies.	Other expenditures.
Total	7,003	$72,662	$54,741	$38,329	$2,285	$7 734	$6,393
Rhode Island	500	10,000	7,800	3,800	.....	2,500	1,500
New York	3,460	42,410	18,370	18,370	.....	.....	.....
Pennsylvania	2,721	16,752	16,979	12,605	.....	3,754	620
Michigan and Wyoming (a)	322	3,500	11,592	3,554	2,285	1,480	4,273

a Michigan and Wyoming are here grouped in order that the business of individual establishments may not be disclosed to the public.

LABOR EMPLOYED.

STATES AND TERRITORIES.	ABOVE GROUND.								
	Average number employed.			Average wages per day.			Average number of days worked.		
	Foremen.	Mechanics.	Laborers.	Foremen.	Mechanics.	Laborers.	Foremen.	Mechanics.	Laborers.
Total	3	13	60	$2.97	$1.93	$1.30	236	235	233
Rhode Island	.....	4	.....	.....	2.00	.....	.....	300	.....
New York	.....	1	30	.....	2.50	1.40	.....	300	300
Pennsylvania	2	7	24	1.96	1.79	1.13	247	191	163
Michigan and Wyoming	1	1	6	5.00	2.00	1.50	213	213	182

STATES AND TERRITORIES.	BELOW GROUND.								
	Average number employed.			Average wages per day.			Average number of days worked.		
	Foremen.	Miners.	Laborers.	Foremen.	Miners.	Laborers.	Foremen.	Miners.	Laborers.
Total	3	14	8	$3.00	$1.82	$1.30	170	203	286
Rhode Island	.....	2	.....	.....	2.25	.....	.....	300	.....
New York	.....	.....	6	.....	.....	1.40	.....	.....	300
Pennsylvania	2	9	2	2.00	1.50	1.00	250	246	245
Michigan and Wyoming	1	3	.....	5.00	2.50	.....	10	10	.....

CAPITAL INVESTED.

STATES AND TERRITORIES	Total value.	In land.	In buildings, machinery, etc.	In tools, implements, live stock, etc.	Cash.
Total	$259,475	$179,800	$41,350	$27,325	$11,000
Rhode Island	30,000	10,000	12,000	5,000	3,000
New York	95,000	50,000	25,000	20,000	.....
Pennsylvania	14,800	10,000	4,000	800	.....
Michigan and Wyoming	119,675	109,800	350	1,525	8,000

MOTIVE POWER.

STATES AND TERRITORIES.	BOILERS.		WATER MOTORS.		Number of animals employed.
	Number.	Total horse power.	Number.	Horse power.	
Total	6	355	1	150	7
Rhode Island	1	125	.....	.....	.....
New York	2	120	1	150	3
Pennsylvania	2	90	.....	.....	2
Michigan and Wyoming	1	20	.....	.....	2

PRODUCTION IN PREVIOUS YEARS.

With the single exception of the mines in New York state, the production of graphite during the past decade has been very spasmodic, and little authentic information can be obtained respecting the amount and value of the product of other localities. The product of crude graphite in 1880 amounted to 940 short tons, worth $49,800, as given in the Tenth Census reports. Those for subsequent years are returns for refined graphite made by the division of mining statistics of the United States geological survey.

PRODUCTION OF REFINED GRAPHITE FROM 1881 TO 1888.

[Pounds.]

YEARS.	Quantity.	Value.
1881	400,000	$30,000
1882	425,000	34,000
1883	575,000	46,000
1884	(a)	.....
1885	327,883	26,231
1886	415,525	33,242
1887	416,000	34,000
1888	400,000	33,000

a Practically nothing.

USES.

From the fact that the very common and useful utensils known as lead pencils are made from graphite the name of black lead has been popularly bestowed upon the mineral. Until a comparatively recent date the use of graphite has been confined to this purpose, to the manufacture of crucibles, and to various preparations for stove polishing, etc. Of late, however, other qualities have been observed, which have opened to the mineral entirely new and extensive fields of usefulness, prominent among which is its consumption as a lubricant. For the bearings of heavy machinery it makes a superior lubricant to oil, is clean, leaves no dripping grease, and one proper application will last as long as the bearings themselves. When the discovery was first made that graphite could be so utilized, some difficulty was encountered in keeping the lubricant in place. As originally employed it was mixed with oil and applied to smooth-surfaced bearings; but, though answering the purpose excellently for awhile, it would creep out and escape, and required constant renewals. This was obviated by the introduction of grooved bushings, the grooves being filled with a composition 75 per cent graphite. The box requires no refilling, and the bearings need no new application until the box is worn out. Graphite bushings of this kind were first applied in 1883 and are growing in favor, being now in very general use. Graphite is also used to a considerable extent for foundry facings and washes, also as a substitute for red lead in making joints and connections, having an advantage

over red lead in that it does not harden, making a perfectly tight joint, that opens easily when the pipe tongs are applied. It is also said to make a good, durable paint for the covering of smokestacks, boilers, tin roofs, and other metal surfaces.

IMPORTS.

The following table shows the quantity and value of graphite imported and entered for consumption in the United States from 1867 to 1889, inclusive:

GRAPHITE IMPORTED INTO THE UNITED STATES FROM 1867 TO 1889, INCLUSIVE.

YEARS ENDED—	Total.	UNMANUFACTURED.		Manufactured. (Value.)
		Quantity. (Cwt.)	Value.	
June 30, 1867	$54,131	27,713	$54,131	.....
1868	149,083	68,629	149,083	.....
1869	351,004	74,846	351,004	.....
1870	270,124	80,795	269,291	$833
1871	139,954	51,628	136,200	3,754
1872	329,030	96,381	329,030	.....
1873	548,613	157,539	548,613	.....
1874	382,591	111,992	382,591	.....
1875	122,050	46,492	122,050	.....
1876	168,314	50,589	150,709	17,605
1877	222,721	75,361	204,630	18,091
1878	171,666	60,244	154,757	16,909
1879	188,650	65,662	164,013	24,637
1880	300,963	109,908	278,022	22,941
1881	413,640	150,927	381,966	31,674
1882	389,371	150,421	363,835	25,536
1883	383,670	154,893	361,949	21,721
1884	288,256	144,086	286,393	1,863
1885	207,228	110,462	207,228	.....
1886	164,111	83,368	164,111	.....
1887	331,621	168,841	331,621	.....
Dec. 31, 1888	353,990	184,013	353,990	.....
1889	378,057	177,381	378,057	.....

SOAPSTONE.

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SOAPSTONE.

BY E. W. PARKER.

VARIETIES AND OCCURRENCE.

Soapstone, or talc, is a hydrated silicate of magnesia, soft, with a soapy feeling, to which it owes its name. There are two principal varieties of the mineral, 1 occurring in massive form, and known as steatite, soapstone, potstone, rensselaerite, etc., the other foliated and fibrous, and not dissimilar in appearance to asbestos. This latter variety, known as fibrous talc, occurs, so far as known, in but one locality in the United States, near the town of Gouverneur, Saint Lawrence county, New York. The ordinary or massive form is distributed liberally throughout the country, and is found in a number of places in Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, Texas, Arizona, and South Dakota. The two varieties are used for entirely different purposes and are treated separately in this report.

PRODUCTION.

The amount of ordinary soapstone produced in the United States in 1889 was 12,715 short tons, valued at $231,708, which represents the aggregate amount received by operators for their product. In some cases the mineral is sold rough or without further preparation than being sawed into slabs convenient for shipping, and in such condition the price ranges between $7 and $10 per ton. About 50 per cent of the entire product is manufactured before being placed upon the market, and the table showing its production is arranged to indicate how much was sold rough or sawed and how much was manufactured, with the value of each. In all instances the labor and wages involved and the capital invested apply to the condition of the product as marketed.

PRODUCTION OF SOAPSTONE IN 1889, BY STATES.

[Short tons.]

STATES.	Total product.	CONDITION IN WHICH PRODUCT WAS FIRST SOLD.				Total value.
		Crude.	Value.	Manufactured.	Value.	
Total	12,715	6,303	$51,575	6,412	$180,133	$231,708
Maryland	432	432	4,321	.....	.....	4,321
New Hampshire	4,252	.....	.....	4,252	117,883	117,883
New Jersey	1,500	1,500	10,262	.....	.....	10,262
Pennsylvania	4,371	4,371	36,992	.....	.....	36,992
Vermont	900	.....	.....	900	20,000	20,000
Virginia	1,260	.....	.....	1,260	42,250	42,250

LABOR AND WAGES.

The highest compensation for foremen was $4 per day, paid in New Hampshire; for mechanics, $2.50 per day, paid in Virginia. Laborers received the highest wages in Vermont, the rate at one quarry being $1.50 per day. The lowest rates per day were as follows: for foremen, $1.50, in New Jersey and Pennsylvania; mechanics, $1, in Virginia; laborers, 75 cents, in Virginia. Boys received the uniform rate of 75 cents per day.

LABOR EMPLOYED AT SOAPSTONE QUARRIES IN 1889, BY STATES, EXCLUSIVE OF FIBROUS TALC OPERATIONS.

STATES.	AVERAGE NUMBER EMPLOYED.				AVERAGE WAGES PER DAY.				AVERAGE NUMBER OF DAYS WORKED.			
	Foremen.	Mechanics.	Laborers.	Boys.	Foremen.	Mechanics.	Laborers.	Boys.	Foremen.	Mechanics.	Laborers.	Boys.
Total	20	71	177	12	$2.60	$1.87	$1.28	$0.75	282	286	275	263
New Hampshire	4	45	54	.....	3.62	1.90	1.40	.....	303	298	292	.....
Pennsylvania	4	2	28	2	1.50	1.75	1.25	0.75	269	281	274	200
Vermont	3	10	19	.....	2.00	1.50	1.38	.....	223	260	237	.....
Virginia	7	14	61	10	3.07	2.07	1.16	0.75	286	268	272	275
Other states (a)	2	.....	15	.....	2.00	.....	1.21	.....	337	.....	272	.....

a The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Maryland and New Jersey.

OPERATING EXPENSES.

STATES.	Total expenditures.	Wages, including office force.	Paid contractors.	Paid for supplies.	Other expenditures.
Total	$163,438	$115,621	$4,023	$35,454	$8,540
New Hampshire	75,750	49,927	3,423	20,000	2,400
Pennsylvania	24,907	13,078	.....	11,104	725
Vermont	12,300	9,700	600	1,000	1,000
Virginia	41,537	36,287	.....	2,900	2,350
Other states (a)	8,944	6,629	.....	450	1,865

a The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Maryland and New Jersey.

CAPITAL INVESTED.

STATES.	Total value.	In land.	In buildings, machinery, etc.	In tools, implements, live stock, etc.	Cash.
Total	$924,900	$431,500	$86,100	$92,300	$15,000
Georgia (a)	250,000	200,000	25,000	25,000	.....
New Hampshire	b350,000	30,000	8,000	7,000	5,000
North Carolina (a)	110,000	104,000	2,000	4,000	.....
Pennsylvania	54,300	32,500	6,100	14,700	1,000
Vermont	20,000	10,000	5,000	2,000	3,000
Virginia	112,000	44,000	28,000	34,000	6,000
Other states (c)	28,600	11,000	12,000	5,600	.....

a No operations in 1889.

b Of this amount $300,000 is represented by capital stock paid in, not distributed.

c The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Maryland and New Jersey.

USES.

The uses for soapstone at the present day are many and various. When exposed to fire or to changes of atmosphere it is one of the most durable substances known, expanding and contracting very little, even at extreme degrees of heat or cold. For this reason it is used very extensively instead of fire brick in the construction of furnaces for the reduction of ores by fluxes, for crucibles, and the linings of boilers, ranges, and heaters. One of its principal uses is for the manufacture of laundry, bath, and acid tubs. It does not absorb acid or grease, and is easily cleansed of any adherent impurities by washing. Soapstone is now receiving some attention as a material for the manufacture of fireproof, waterproof, and acidproof paint. For this purpose it is useful as a protective covering for iron and steel ships and other marine structures, for preserving limestone and sandstone structures against atmospheric changes, and in a number of similar ways. In this application of soapstone to the arts it may be said that the civilization of China has shown greater advancement than that of the western hemisphere. In China soapstone is largely used for preserving structures built of sandstone and other stones which are liable to disintegrate under atmospheric influences, and the covering of powdered soapstone in the form of paint on some obelisks in China, which were hewn out of stones liable to suffer from climatic changes, is said to have preserved the same intact for hundreds of years. Soapstone possesses one peculiar quality which fits it for the manufacture of a protective paint for metals, and that is the extreme fineness of its grain. Ground soapstone is one of the finest

materials which can be produced, and adheres easily and firmly to iron and steel. Moreover, it is lighter than metallic pigments, and if mixed as a paint will cover a larger surface than zinc white, red lead, or oxide of iron. It is used as a lubricant in the form of what is known as steatite grease, and is said to be invaluable as a preventive of hot boxes. It finds some use as a base for cosmetics, for polishing glass and marble, and for the manufacture of interior wall coverings, and is also made into slate pencils. In Alabama soapstone is used for headstones, and it makes excellent hearths, griddles, and mantels. It is also used for dressing skins, leather, etc., and as an adulterant in the manufacture of soap, paper, and rubber. Possessing no poisonous or injurious constituents, it is, therefore, not harmful as an adulterant, except in reference to honesty in weight. Soapstone was used to a very large extent by the Indians of North America, and Dr. W. H. Holmes, of the United States geological survey, who has been for some time engaged in the investigation of that subject, has kindly furnished the following interesting data concerning it:

Among the many varieties of rocks utilized by the American aborigines soapstone took a prominent place. The advantage of a mineral that would withstand measurably the action of fire was no doubt recognized at a very early period, and the fact that it was so easily reduced to desired shapes led first to the production of vessels for cooking and boiling and afterward to the manufacture of pipes and many fanciful forms used in councils and religious ceremonies and in medicinal arts.

The quarrying and working of soapstone by the native races were most extensively practiced along the coast of California, but there are few known localities of this material where some traces of native operations have not been found. The broad soapstone-bearing belt which extends along the Atlantic slope from Maine to Georgia abounds in ancient quarries, and upon a single site within the suburbs of Washington city many pits are still traceable and thousands of fragments of partially finished pots occur upon the surface of the ground and throughout the soil and débris. Many of these ancient quarries have been reworked by the whites, and in numerous cases the traces of aboriginal work have been wholly obliterated.

The natives employed rude tools of stone, and probably also of wood and bone, or antler, in their mining operations. Owing to the massiveness and toughness of the rock, and the difficulty of removing the accumulations of earth and débris, they seldom penetrated to a depth of more than a few feet. Masses of suitable size were broken off or were separated from the bed by the laborious process of picking with stone tools. With smaller picks and chisels of slate, quartz, quartzite, and tough volcanic rocks the bowls of the utensils were roughed out on the quarry site. The half-finished vessels were carried away to dwelling sites and were there finished at leisure by means of small chisels, scrapers, and rubbing stones. At best the vessels are heavy and rather rude as compared with earthen vessels of the same region. Native pipes made of this material are often elaborate and handsome in shape, and of exquisite finish.

FIBROUS TALC.

The fibrous variety of talc or soapstone quarried at Gouverneur, New York, is especially valuable as a filler in the manufacture of paper. One of its valuable characteristics in this respect is its light bluish tinge, which gives to the paper an excellent white color. It is not used in the very finest papers, nor in the coarsest grades, but is consumed to a large extent in the intermediate qualities. Its light weight and fibrous nature admit of its almost entire incorporation with the other ingredients of paper manufacture. The production of fibrous talc at Gouverneur, New York, in 1889 was 23,746 tons, valued at $244,170.

PROCESS OF PREPARATION.

In preparing the talc to be used for making paper it is first crushed into pieces small enough to be ground by buhrstones. After grinding, it is placed, with a quantity of flint pebbles, in large iron cylinders lined with porcelain, and the talc is reduced to the desired fineness by friction against the sides of the cylinders and the pebbles. It is then packed and delivered to the trade under various names, such as mineral pulp, asbestine pulp, agalite, etc.

INCREASE IN THE PAST DECADE.

By comparing the product of soapstone and fibrous talc for the year 1889 with that of the Tenth Census year it will be observed that there is a gain in the quantity of the former of about 51 per cent. The increase in value is 248 per cent. This large percentage is probably due to the amount of soapstone produced in 1889 which was sold in the manufactured state. The percentage of increase in the product of fibrous talc is 464 per cent, and in value 346 per cent.

The following table shows the product and value of 1880 as compared with that of 1889, by states:

COMPARATIVE STATISTICS OF SOAPSTONE FOR 1880 AND 1889, BY STATES.

STATES.	PRODUCT. (Short tons.)		Increase. (Short tons.)	Decrease. (Short tons.)	VALUE.		Increase.	Decrease.
	1880.	1889.			1880.	1889.		
Total	8,441	12,715	4,274	.....	$66,665	$231,708	$165,043	.....
Georgia	320	.....	.....	320	710	.....	.....	$710
Maryland	300	432	132	.....	1,950	4,321	2,371	.....
New Hampshire	2,000	4,252	2,252	.....	30,000	117,883	87,883	.....
New Jersey	.....	1,500	1,500	.....	.....	10,262	10,262	.....
North Carolina	510	.....	.....	510	5,100	.....	.....	5,100
Pennsylvania	4,011	4,371	360	.....	17,055	36,992	19,937	.....
Vermont	1,300	900	.....	400	11,850	20,000	8,150	.....
Virginia	.....	1,260	1,260	.....	.....	42,250	42,250	.....

STATES.	TOTAL NUMBER OF EMPLOYÉS.		TOTAL WAGES PAID.		OTHER EXPENSES.		TOTAL EXPENSES.	
	1880.	1889.	1880.	1889.	1880.	1889.	1880.	1889.
Total	113	280	$29,455	$115,621	$2,841	$47,817	$32,296	$163,438
Georgia	12	.....	390	.....	100	.....	490	.....
Maryland	4	5	734	2,245	114	265	848	2,510
New Hampshire	30	103	12,000	49,927	950	25,823	12,950	75,750
New Jersey	.....	12	.....	4,384	.....	2,050	.....	6,434
North Carolina	15	.....	2,500	.....	.....	.....	2,500	.....
Pennsylvania	27	36	7,931	13,078	552	11,829	8,483	24,907
Vermont	25	32	5,900	9,700	1,125	2,600	7,025	12,300
Virginia	.....	92	.....	36,287	.....	5,250	.....	41,537

TALC IMPORTED INTO THE UNITED STATES FROM 1880 TO 1889, INCLUSIVE.

[Pounds.]

YEARS.	Quantity.	Value.
1880	.....	$22,807
1881	.....	7,331
1882	.....	25,641
1883	.....	14,607
1884	.....	41,165
1885	.....	24,356
1886	.....	24,514
1887	.....	49,250
1888	*a*24,165	22,446
1889	19,229	30,993

a Quantity not reported previous to 1888.

BARYTES.

BARYTES.

BY E. W. PARKER.

Barytes, or natural barium sulphate, is a well-known mineral and liberally distributed, but it is only recently that it has become of any commercial importance. Barium sulphate has been prepared artificially for a number of years, and is used to a considerable extent in the place of white lead, which it resembles closely. Improvements in machinery and in the processes of treating natural barytes have overcome many of the objections which formerly existed to its utilization, and considerable attention is now being given to the localities in the United States where it is found. The mineral, in order to be available for the uses to which it is put, must be fairly free from quartz grains, the stain of iron rust, or other impurities. If the barytes is stained to any extent it is practically valueless, as a good white color is essential to its usefulness. Quartz grains or other hard substances with which it is apt to be associated injure the machinery in grinding. The purest barytes so far produced in this country comes from Missouri, though a very fair grade is now being mined in considerable quantities in Virginia.

PRODUCTION IN 1889.

The returns from all producers of crude barytes show a product in the United States for 1889 of 21,460 short tons, valued at $106,313, against 22,400 short tons in 1888, valued, approximately, at $110,000.

The production was limited to four states, as shown in the following table:

PRODUCTION OF BARYTES IN 1889, BY STATES.

[Short tons.]

STATES.	Quantity.	Value.
Total	21,460	$106,313
Illinois	200	1,300
Missouri	7,558	32,715
North Carolina	3,000	15,000
Virginia	10,702	57,298

LABOR AND WAGES.

Barytes mining in Missouri is carried on in such a very irregular manner that it is impossible to obtain any reliable statistics relative to labor and wages. Farmers mine it in off seasons; that is, when there is no farming to do they employ themselves and their hands in getting out the barytes found on their farms, haul it to the nearest tradesman, and receive in exchange dry goods, groceries, or other necessaries, or cash. The farmers thus occupy time which would otherwise be idle, and dispose of the barytes at a less figure than it would pay to mine it systematically. The supply thus obtained is nearly sufficient to keep the mills up to their fullest capacity.

A few mines are, however, operated with some degree of system, though for want of proper records it is necessary to estimate a considerable portion of the matter of labor and wages. The mines altogether give irregular employment to about 580 men. The rate of compensation for foremen is about $2.50 per day, and for laborers from $1 to $1.50 per day. It is rarely, however, that the men make full time, and their daily earnings are reported at from 50 to 75 cents. From 75 to 100 women obtain the same sort of irregular employment, earning about 35 cents per day. Boys get from 25 to 30 cents per day. One mine was active nearly the entire year, but in most cases the number of days worked at the mines ranged from 125 to 200. One mine in Illinois employed 10 men and 2 women for 52 days.

The number of men employed in Virginia and North Carolina and the average wages paid each class are shown in the following table:

NUMBER OF EMPLOYÉS AND WAGES PAID AT BARYTES MINES IN VIRGINIA AND NORTH CAROLINA.

EMPLOYÉS.	Average number employed.	Average wages per day.	Average number of days worked.
Total	215		
Foremen (*a*)	11	$1.70	220
Mechanics (*b*)	7	1.43	20
Miners	85	0.85	200
Laborers (*c*)	107	0.68	225
Boys under 16 years of age	5	0.35	22

a Of the foremen, 4 were employed above ground, and 7 below.
b All above ground.
c Of the laborers, 29 were employed above ground and 78 below.

OPERATING EXPENSES.

The following statement shows the amount of money paid for operating and developing barytes mines in Virginia, North Carolina, and Illinois:

WAGES AND OTHER EXPENDITURES AT BARYTES MINES IN VIRGINIA, NORTH CAROLINA, AND ILLINOIS.

Wages (including office force at mines)	$54,524
Paid for supplies	8,200
Other expenditures (rent, taxes, insurance, etc.)	2,083
Total	64,807

CAPITAL.

The amount of capital represented in barytes mines in the United States is shown in the following statement, and only refers to such properties as were worked in 1889. The aggregate value of the lands on which barytes is found in Missouri is placed at $4,500,000, but the estimates are based on prospects rather than on actual development.

CAPITAL INVESTED IN BARYTES MINES IN THE UNITED STATES.

In land	$184,450
In buildings, machinery, etc	66,450
In tools, implements, live stock, etc	76,350
Cash	23,900
Total	351,150

USES.

The consumption of barytes seems to be steadily increasing. It is used quite extensively in the arts, finding its greatest service as an adulterant in the manufacture of paint. Its great weight, its likeness in many respects to white lead, and the fact that it can be used in place of that commodity, enables manufacturers to replace the costlier article with a substitute, much to their own advantage. It is claimed by some that a mixture composed of one-third barytes, one-third zinc white, and one-third white lead makes a better paint than the pure white lead. This is probably true for some special purposes. Barytes is remarkable for its weight, having a specific gravity of about 4.5, or about the same as iron ore. It can therefore be used with white lead without any appreciable loss of weight in the mixture.

PROCESS OF MANUFACTURE.

In the Mineral Resources of the United States for 1885 a brief description is given of the process of manufacturing or floating barytes. The processes have not materially changed since that date, and are about as follows:

The crude barytes, having first been assorted and cleaned, is ground or crushed to about the size of buckshot. It is then treated with sulphuric acid, for the purpose of removing iron stains and other impurities with which barytes is apt to be discolored, and afterward boiled in distilled water, dried by steam, and pulverized. The pulverized barytes is then placed in large vats and mixed with water, and part of the mixture settles rapidly. That which floats longest is the best suited for the manufacture of paint, and is drawn off, dried again by steam, and is then barreled and ready for market. It is thus that the name "floated barytes" is derived. The floated barytes finds a steady market at from $19 to $32 per ton, according to quality, purity of color, etc.

NEW DEVELOPMENTS.

Besides the localities from which the supply has been thus far derived, there are deposits in South Carolina which are now being investigated with prospects of development at an early date. The mineral is found along the line of the Charleston, Cincinnati and Chicago railroad, in the building of which a considerable vein was exposed, but occurs in largest quantities in the vicinity of Kings Creek, where a side track can be run in and the material loaded on cars. Lack of transportation was one of the drawbacks to its development in the past, but this difficulty has been removed by the railroad builders. Diffused through the barytes is a small percentage of quartz grains, which make it necessary to use other grinding machinery than the buhr mills ordinarily used for that purpose. It is expected that mills for this purpose will be put up in the vicinity of the mines, thereby insuring a more profitable business than can be obtained by sending the barytes elsewhere to be ground and floated.

At Terrazas station, state of Chihuahua, Mexico, there are some 6 or 8 veins of barytes from 1 to 5 feet thick, said to be of a good white color, free from yellow, brown, or black iron stains, and a considerable portion of which is a very delicate pale-blue tint, considered valuable in the highest classes of barytes, as it tends to neutralize the yellowish tint of inferior qualities. The company owning the property upon which these veins are found offered to sell the barytes in car loads at $5 per short ton, free on board cars at the shipping point.

The following table shows the production of barytes since 1882. No statistics have been published prior to that year.

PRODUCT OF CRUDE BARYTES FROM 1882 TO 1889, INCLUSIVE.(a)

[Short tons.]

YEARS.	Quantity.	Value.
1882	22,400	$80,000
1883	30,240	108,000
1884	28,000	100,000
1885	16,800	75,000
1886	11,200	50,000
1887	16,800	75,000
1888	22,400	110,000
1889	21,460	106,313

a The production given for years previous to 1889 is mostly estimated, and the figures are probably slightly exaggerated.

IMPORTS.

Nearly all, if not all, of the barium sulphate imported into the United States is artificially prepared. Importations are quoted under various names, such as blanc-fixe, or permanent white, satin white, enameled white, lime white, etc.

IMPORTS OF BARIUM SULPHATE FROM 1867 TO 1889, INCLUSIVE.

[Pounds.]

YEARS ENDED—	MANUFACTURED.		UNMANUFACTURED.	
	Quantity.	Value.	Quantity.	Value.
June 30, 1867	14,968,181	$141,273	.....	.....
1868	2,755,547	26,739	.....	.....
1869	1,117,335	8,565	.....	.....
1870	1,684,916	12,917	.....	.....
1871	1,385,004	9,769	.....	.....
1872	5,804,098	43,521	.....	.....
1873	6,939,425	53,759	.....	.....
1874	4,788,966	42,235	.....	.....
1875	2,117,854	17,995	.....	.....
1876	2,655,349	25,325	.....	.....
1877	2,388,373	19,273	.....	.....
1878	1,366,857	10,340	.....	.....
1879	453,333	3,496	.....	.....
1880	4,924,423	37,374	.....	.....
1881	1,518,322	11,471	.....	.....
1882	562,300	3,856	.....	.....
1883	411,666	2,469	.....	.....
Dec. 31, 1884	3,884,516	24,671	5,800,816	$8,044
1885	4,095,287	20,606	7,841,715	13,567
1886	3,476,691	18,338	6,588,872	8,862
1887	4,057,831	19,769	10,190,848	13,205
1888	3,821,842	17,135	6,504,975	9,037
1889	3,601,566	22,458	13,571,206	7,669

OCHER AND METALLIC PAINT.

OCHER AND METALLIC PAINT.

BY E. W. PARKER.

For commercial purposes it has become customary to separate pigments manufactured from iron oxides into two classes, viz, "ocher" and "metallic paint". The former term is usually applied to paints made from clays to which the natural mixing of iron peroxide and water has imparted a bright-red or reddish-yellow color, and the latter to the darker red and brown paints manufactured from iron ores. These distinctions are adhered to in this report.

OCHER.

The production of ocher for 1880, as obtained by the Tenth Census, was 4,037 tons, valued at $135,840. The product in 1889 was 15,158 tons, valued at $177,472, showing an increase in tonnage of 275 per cent and an increase in value of only about 31 per cent. This difference in tonnage and value is, in all probability, due to the values of the product being taken at different stages of manufacture. The high estimate placed upon the product of 1880 would indicate that prices were taken for the manufactured article, whereas the values in the present investigation were obtained for the mineral in the condition in which it was first sold, freights eliminated.

The statement of the production by states in 1880, as compared with that of 1889, is shown in the following table:

COMPARATIVE PRODUCTION OF OCHER FOR 1880 AND 1889, BY STATES.

[Short tons.]

STATES.	1880.		1889.	
	Quantity.	Value.	Quantity.	Value.
Total	4,037	$135,840	15,158	$177,472
Alabama			336	3,500
Colorado			50	150
Georgia			2,512	29,720
Maryland			616	12,000
Massachusetts			80	750
New Jersey	300	1,350		
Pennsylvania			7,922	103,797
Vermont	1,750	27,750	1,884	7,800
Virginia	1,987	106,740	1,658	18,755
Wisconsin			100	1,000

PRODUCTION IN OTHER YEARS.

According to Mineral Resources of the United States, the amount of ocher produced in this country from 1881 to 1886 was estimated at about 7,000 tons annually. This was increased in 1887 to 8,000 tons, and a further increase to 10,000 tons was noted in 1888. The difference of 5,158 tons between the estimated product for 1888 and the amount shown by the census returns indicates that the estimates for previous years were considerably less than the actual production.

LABOR AND WAGES.

The following tables show the number of men employed at ocher mines in the United States in 1889, the average wages per day, the number of days worked, the operating expenses, and capital invested:

MEN EMPLOYED AND WAGES PAID AT OCHER MINES IN 1889, BY STATES.

STATES.	FOREMEN.			MECHANICS.			LABORERS.			BOYS UNDER 16 YEARS.		
	Average number employed.	Average wages per day.	Average number of days worked.	Average number employed.	Average wages per day.	Average number of days worked.	Average number employed.	Average wages per day.	Average number of days worked.	Average number employed.	Average wages per day.	Average number of days worked.
Total	17	$2.07	236	14	$1.68	264	162	$1.12	228	3	$0.50	200
Georgia	2	2.35	300	2	1.25	220	25	1.00	188	.....	.....	.....
Pennsylvania	6	1.77	290	8	1.75	300	61	1.18	291	.....	.....	.....
Vermont	1	1.33	300	.....	.....	.....	15	1.11	195	.....	.....	.....
Virginia	3	1.67	225	4	1.75	213	31	1.00	207	.....	.....	.....
Wisconsin	1	5.00	20	.....	.....	.....	3	2.50	20	.....	.....	.....
Other states (*a*)	4	2.15	170	.....	.....	.....	27	1.06	188	3	0.50	200

a The states here grouped, in order that the business of individual establishments may not be disclosed, embrace Alabama, Colorado, Maryland, and Massachusetts.

OPERATING EXPENSES.

STATES.	Grand total expenditures.	Total wages, including office force.	Paid for supplies.	Other expenditures.
Total	$86,247	$59,695	$19,011	$7,541
Georgia	12,491	7,006	3,960	1,525
Pennsylvania	41,536	29,966	10,096	1,474
Vermont	6,670	3,623	1,280	1,767
Virginia	14,080	10,780	2,550	750
Wisconsin	365	250	115	.....
Other states (*a*)	11,105	8,070	1,010	2,025

a The states here grouped, in order that the business of individual establishments may not be disclosed, embrace Alabama, Colorado, Maryland, and Massachusetts.

CAPITAL INVESTED.

STATES.	Total.	In land.	In buildings, machinery, etc.	In tools, etc.	Cash.
Total	$386,453	$249,560	$68,693	$45,750	$22,450
Georgia	89,000	47,500	21,600	14,900	5,000
Pennsylvania	60,600	40,900	14,500	4,500	700
Vermont	12,510	6,810	3,600	2,100	.....
Virginia	30,000	13,000	7,500	4,000	5,500
Wisconsin	15,000	10,000	3,500	1,500	.....
Other states (*a*)	179,343	131,350	17,993	18,750	11,250

a The states here grouped, in order that the business of individual establishments may not be disclosed, embrace Alabama, Colorado, Maryland, and Massachusetts.

METALLIC PAINT.

There are no statistics of the production of metallic paint published in the mining volume of the Tenth Census. In 1856 the discovery of an iron ore valuable for the manufacture of metallic paint was made in Carbon county, Pennsylvania, near the Lehigh river, and at no time since the original discovery have the mines been idle. The production in the United States in 1889 from all sources amounted to 21,026 short tons, valued at $286,294, as follows:

PRODUCTION OF METALLIC PAINT IN THE UNITED STATES IN 1889, BY STATES.

[Short tons.]

STATES.	Quantity.	Value.
Total	21,026	$286,294
Alabama	3,000	30,000
Colorado	90	2,500
New York	3,658	64,698
Ohio	540	11,123
Pennsylvania	8,845	128,036
Tennessee	3,057	24,237
Wisconsin	1,852	26,700

LABOR AND WAGES.

The following table is arranged to show by states the number of men employed at metallic paint mines, the average wages paid, and the number of days worked by each class of employés:

LABOR EMPLOYED AT METALLIC PAINT MINES IN THE UNITED STATES IN 1889, BY STATES.

STATES.	FOREMEN.			MECHANICS.			LABORERS.			BOYS UNDER 16 YEARS.		
	Average number employed.	Average wages per day.	Average number of days worked.	Average number employed.	Average wages per day.	Average number of days worked.	Average number employed.	Average wages per day.	Average number of days worked.	Average number employed.	Average wages per day.	Average number of days worked.
Total	10	$2.42	250	27	$1.90	262	151	$1.34	259	3	$0.67	97
New York	2	3.00	300	4	1.73	171	22	1.44	204	1	1.00	175
Ohio	2	2.25	181	1	2.00	150	10	1.43	139	.....	.....	.....
Pennsylvania (a)	1	1.25	276	16	1.81	295	83	1.30	281	.....	.....	.....
Tennessee	1	2.50	300	1	2.00	300	13	1.16	254	.....	.....	.....
Wisconsin	2	2.21	214	3	2.33	228	10	1.60	134	2	0.50	58
Other states (b)	2	2.75	268	2	2.25	268	13	1.31	295	.....	.....	.....

a Under laborers are included 25 miners at $1.40 per day and 12 laborers at $1.25 per day (300 days each) below ground.

b The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Alabama and Colorado.

OPERATING EXPENSES.

STATES.	Total paid for labor.	OFFICE FORCE.				Grand total expenditures.	Grand total of wages.	Total paid contractors.	Paid for supplies.	Other expenditures.
		Males.		Females.						
		Number.	Wages paid.	Number.	Wages paid.					
Total	$69,820	7	$5,440	1	$100	$163,787	$75,360	$8,674	$65,498	$14,255
New York	10,603	1	540	.....	.....	24,064	11,143	5,146	4,705	3,070
Ohio	3,124	.....	.....	.....	.....	3,173	3,124	.....	14	35
Pennsylvania	38,047	3	2,500	.....	.....	103,031	40,547	3,498	50,001	9,075
Tennessee	4,950	.....	.....	.....	.....	4,950	4,950	.....	.....	.....
Wisconsin	5,484	2	1,800	1	100	19,057	7,384	120	9,978	1,575
Other states (a)	7,612	1	600	.....	.....	9,512	8,212	.....	800	500

a The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Alabama and Colorado.

CAPITAL INVESTED.

STATES.	Total.	In land.	In buildings, machinery, etc.	In tools, etc.	Cash.
Total	$462,164	$222,100	$128,700	$69,064	$42,300
New York	86,164	10,500	51,350	18,314	6,000
Ohio	60,000	32,000	19,000	7,500	1,500
Pennsylvania	207,700	126,500	29,100	26,100	26,000
Tennessee	20,200	6,100	9,050	4,050	1,000
Wisconsin	48,000	28,500	8,600	4,100	6,800
Other states (a)	40,100	18,500	11,600	9,000	1,000

a The states here grouped, in order that the business of individual establishments may not be disclosed to the public, embrace Alabama and Colorado.

FLUORSPAR.

FLUORSPAR.

BY E. W. PARKER.

PRODUCTION.

The production of fluorspar in the United States in 1889 was limited to one locality, near Rosiclare, Illinois. The product was 9,500 tons, valued at $45,835, an increase of 3,500 tons over the product of 1888. There has been little fluctuation in price.

The following table gives the quantity and value of fluorspar produced in the United States for all the years for which figures are obtainable:

PRODUCTION OF FLUORSPAR IN THE UNITED STATES FROM 1882 TO 1889, INCLUSIVE.

[Short tons.]

YEARS.	Quantity.	Value.
1882	4,000	$20,000
1883	4,000	20,000
1884	4,000	20,000
1885	5,000	22,500
1886	5,000	22,000
1887	5,000	20,000
1888	6,000	30,000
1889	9,500	45,835

LABOR AND WAGES.

The mining of fluorspar gives employment to about 100 men, who work an average of 200 days in the year. The demand for the mineral is not heavy, and the mines are operated only about two-thirds of the time. The distribution of the men employed and the wages paid each class are shown in the following table:

LABOR AND WAGES.

EMPLOYÉS.	Average number employed.	Average wages per day.
Total	101	.....
Above ground:		
Foremen	3	$2.42
Mechanics	8	1.62
Laborers	60	1.25
Boys under 16 years of age	2	0.50
Below ground:		
Foremen	1	2.00
Miners	18	1.50
Laborers	9	1.25

COST OF PRODUCTION.

The expenses incurred in the mining of fluorspar in the United States for the year 1889 were as follows:

OPERATING EXPENSES.

Wages	$14,213
Paid for supplies	5,025
Other expenses	3,008
Total	22,246

CAPITAL INVESTED.

The amount of capital represented in the industry is $192,000, distributed as follows:

CAPITAL INVESTED.

In land	$131,000
In buildings, machinery, etc	12,500
In tools, implements, live stock, etc	13,000
Cash used as working capital	35,500
Total	192,000

USES.

Fluorspar is used principally as a flux in melting iron in foundries, for the manufacture of opalescent glass, and for producing hydrofluoric acid for chemical purposes.

IMPORTS.

Fluorspar (calcium fluoride) is not imported into the United States, but is obtained as a by-product in the reduction of cryolite to the salts of aluminum and sodium. All of the cryolite consumed in the United States is imported from Greenland. The amount of cryolite imported into the United States from 1871 to 1889, inclusive, is shown in the following table:

IMPORTS OF CRYOLITE FOR THE YEARS 1871 TO 1889, INCLUSIVE.

[Long tons.]

YEARS ENDED—	Quantity.	Value.
June 30, 1871		$71,058
1872		75,195
1873		84,226
1874		28,118
1875		70,472
1876		103,530
1877		126,692
1878		105,884
1879		66,042
1880		91,366
1881		103,529
1882	3,758	51,589
1883	6,508	97,400
1884	7,390	106,029
Dec. 31, 1885	8,275	110,750
1886	8,230	110,152
1887	10,328	138,068
1888	7,388	98,830
1889	8,603	115,158

LITHOGRAPHIC STONE.

LITHOGRAPHIC STONE.

BY E. W. PARKER.

In Mineral Resources of the United States for 1886 it is stated that there were promising indications of an early production of domestic lithographic stone to take the place of the Bavarian article, the supply of which is rapidly decreasing. The promise has not been fulfilled. That lithographic stone of good quality and in workable quantity exists in this country there seems to be every reason to believe, but no amount sufficient to be considered a factor in the mining industry has yet been produced, certainly not enough to enter as a competitor with Bavarian stone. During 1886 it is reported that lithographic stone from Clay and Overton counties, Tennessee, was tested by lithographers with highly satisfactory results, but inquiry has failed to discover any records of production since that date. Lithographic stone exists in Blanco and Burnet counties, Texas, and a company has been formed for the purpose of developing the properties in Blanco county.

Mr. H. J. Peyton, of Burnet, Burnet county, reports lithographic stone on his property, but he has not been able to develop it. Mr. Kenneth C. Kerr, special agent of the Census Office, reports a lithographic stone deposit near the town of Santaquin, Utah county, Utah, upon which it was expected to begin operations at an early date. The only locality in the country where lithographic stone was quarried during the year 1889 was in Hardin county, Kentucky, 8 miles northeast of Elizabethtown. The amount of stone taken out was 18 tons, producing 1,200 pounds of the merchantable article, valued at $243. In producing this amount 1 foreman at $1.65 per day and 1 mechanic and 1 laborer at 75 cents each per day were employed. The amount of wages paid was $154. Supplies to the value of $200 were consumed, and $228 was paid for other expenses. As in all cases where only pioneer work has been done, the expenditures were in excess of the value of the product.

Lithographic stone is also reported near the town of Tomahawk, Searcy county, Arkansas, and a company has been organized for the purpose of quarrying it, but had not begun operations up to the close of 1889.

TESTS OF DOMESTIC STONE.

During the course of the present investigation inquiries were addressed to many of the leading lithographers of the country for the purpose of ascertaining definitely what tests of domestic stone had been made. To these inquiries a large number of replies were received. In a number of instances the tests were highly satisfactory, and specimens of work done upon domestic stone have been submitted, which show to fair advantage. It must be confessed, however, that in many cases the domestic lithographic stone is faulty, sometimes due to the presence of minute crystals of marble or quartz; at other times to different degrees of hardness in the stone itself, rendering it in either case worthless except for cheap work or for the execution of very small designs. It is confidently hoped by those interested in such properties that the imperfections are due to atmospheric influences, affecting only the stone near the surface, and that they will disappear as greater depth is reached. From present indications the supply of Bavarian stone is nearly exhausted, and it is safe to predict that within a few years greater attention will be given to the possibility of American stone furnishing the supply, not only for home consumption but for foreign demand as well.

FIRMS THAT HAVE TESTED DOMESTIC STONE.

The following lithographers in the United States have tried the qualities of different domestic lithographic stones, with varying results, generally favorable:

Mr. O. V. Greend, New Orleans, Louisiana.
Messrs. Lehman & Bolton, Philadelphia, Pennsylvania.
The Strobridge Lithographing Company, Cincinnati, Ohio.
The Los Angeles Lithographic Company, Los Angeles, California.
The National Bureau of Engraving and Manufacturing Company, Philadelphia, Pennsylvania.
Mr. A. L. Porter, Chicago, Illinois.

IMPORTS.

The imports of unengraved lithographic stone during late years have been as follows:

LITHOGRAPHIC STONE IMPORTED INTO THE UNITED STATES FROM 1868 TO 1889, INCLUSIVE.

Years ended—		Years ended—	
June 30, 1868	$13,258	June 30, 1879	$37,746
1869	17,044	1880	56,310
1870	14,225	1881	77,894
1871	21,311	1882	111,925
1872	36,146	1883	104,313
1873	44,937	1884	128,035
1874	36,902	1885	54,022
1875	41,963	1886	71,009
1876	47,101	Dec. 31, 1887	83,182
1877	44,503	1888	113,365
1878	42,709	1889	78,077

SULPHUR.

SULPHUR.

BY E. W. PARKER.

PRODUCING LOCALITIES IN 1889.

Although deposits of sulphur are reported to have been discovered in a number of places throughout the United States, in only 4 states have there been developments of any commercial importance, and in but 2 of these, Utah and Nevada, was there any production in 1889. In Nevada work was just begun during the year, the beds being located near the town of Winnemucca, and said to be very valuable. The mine producing sulphur in 1889 in Utah is located about 12 miles south of the town of Frisco. The total output of these 2 mines was 1,150 short tons of ore, producing 450 tons of sulphur, valued at $7,850, as shown in the following table:

PRODUCTION OF SULPHUR FOR 1889.

[Short tons.]

STATES AND TERRITORIES.	Amount of ore produced.	Refined sulphur.	Value.
Nevada	550	250	$3,850
Utah	*a*600	200	4,000

a Estimated.

The following tables include the men employed at both places above and below ground, the wages paid per day, the number of days employed, the expenses incurred in operating the mines, and the amount of capital invested:

LABOR EMPLOYED.

EMPLOYÉS.	Average number employed.	Average wages per day.	Average number of days worked.
Total	12	.....	.....
Foremen	2	$4.50	89
Miners	7	3.00	77
Boys under 16 years of age	3	0.50	69

OPERATING EXPENSES.

Paid for wages	$2,410
Paid for supplies	1,700
Total	4,110

CAPITAL INVESTED.

In land	*a*$312,500
In buildings, machinery, etc	2,750
In tools, implements, live stock, etc	5,500
Total	320,750

a Includes valuation of Louisiana property.

PREVIOUS OPERATIONS AND PRODUCTION.

Prior to 1889 sulphur deposits of notable value had been located in California, Louisiana, and Utah. In California it has been found in about 10 counties, but with the exception of the deposit at Clear Lake, Lake county, no work has been done. In 1864 a refinery, with a capacity of 6 tons per day, was erected at this place, and until 1868 was engaged in the refining of sulphur, but owing to a drop of about 50 per cent in the price of refined sulphur at San Francisco the enterprise ceased to be profitable and was abandoned.

It is stated that the Mormons refined sulphur from native ore as early as 1850. About the year 1870 considerable prospecting was done in the neighborhood of Cove creek, and during the next 2 years several claims were located, and a few have been developed. The Dickert & Myers Sulphur Company, organized in 1883, was engaged up to 1888 in operating the deposits in the vicinity of Cove creek.

The sulphur beds of Louisiana are located about 12 miles from Lake Charles and 80 miles west of New Orleans. The discovery of the sulphur-bearing stratum was the result of explorations after petroleum, which, from surface indications, it was thought could be found in profitable quantity. In this the prospectors were disappointed, but their disappointment was in a measure offset by the discovery, at the depth of 443 feet, of a stratum of sulphur, said to be of exceptional purity. A company was formed for the purpose of developing the property, and a shaft was sunk to the depth of 150 feet, when an accident stopped the work. Up to 1889 no further work had been done, but in that year the property changed hands, and the present owner expects to commence operations shortly.

IMPORTS.

The amount of sulphur produced in the United States is small, indeed, compared to that imported into the country. This is due largely to the excessive cost of transportation from the western mines, it being possible to put down Sicilian sulphur in New York at a lower figure than it would cost to transport the product of Utah or Nevada. The following table shows the imports of sulphur for the years 1867 to 1889, inclusive:

SULPHUR IMPORTED INTO THE UNITED STATES FROM 1867 TO 1889, INCLUSIVE.

[Long tons.]

YEARS ENDED—	CRUDE.		"FLOWERS" OF SULPHUR.		REFINED.		Ore. (a)	Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
June 30, 1867	24,544	$620,373	110	$5,509	251	$10,915	.....	$636,797
1868	18,151	446,547	16	948	65	2,721	.....	450,216
1869	23,590	678,642	97	4,576	645	27,149	.....	710,367
1870	27,380	819,408	76	3,927	157	6,528	$1,269	831,132
1871	36,131	1,212,448	66	3,514	92	4,328	754	1,221,044
1872	25,380	764,798	36	1,822	57	2,492	.....	769,112
1873	45,533	1,301,000	55	2,924	36	1,497	.....	1,305,421
1874	40,990	1,260,491	51	2,694	57	2,403	.....	1,265,588
1875	39,683	1,259,472	18	891	.....	.....	.....	1,260,363
1876	46,435	1,475,250	41	2,114	44	1,927	.....	1,479,291
1877	42,963	1,242,888	116	5,873	1,171	36,962	.....	1,285,723
1878	48,102	1,179,769	159	7,628	150	5,935	.....	1,193,332
1879	70,370	1,575,533	138	6,509	69	2,392	.....	1,584,434
1880	87,837	2,024,121	124	5,516	158	5,262	.....	2,034,899
1881	105,097	2,713,485	98	4,226	71	2,555	.....	2,720,266
1882	97,504	2,627,402	159	6,926	59	2,196	.....	2,636,524
1883	94,540	2,288,946	79	3,262	115	4,487	.....	2,296,695
1884	105,112	2,242,697	178	7,869	126	4,765	.....	2,255,331
1885	96,839	1,941,943	121	5,351	114	4,060	.....	1,951,354
1886	117,538	2,237,989	213	8,739	116	3,877	.....	2,250,605
1887	96,882	1,688,360	279	9,980	84	2,383	.....	1,700,723
Dec. 31, 1888	120,104	1,927,336	60	1,921	.....	3	.....	1,929,260
1889	135,935	2,068,208	282	8,184	10	299	.....	2,076,691

a Since 1871 classed under the head of pyrites.

PRINCIPAL SOURCES OF SUPPLY.

Italy and the island of Sicily furnish the larger part of the world's supply of sulphur, 90 per cent coming from Sicily. The sulphur-producing districts of Sicily cover about one-third of the entire island, and include nearly all of the provinces of Girjenti and Caltanisetta. A few mines are also found in the provinces of Palermo and Catania. Some sulphur is produced at Hakodadi, in Japan, most of which is shipped to San Francisco. The trade in Japanese sulphur is limited on account of poor facilities for mining and shipping. The ore is said to be of good quality, yielding 50 per cent of sulphur. The sulphur mines of Sicily, on the other hand, while not possessing the richness of ore claimed for the Japanese, are conveniently situated for shipping the product and labor is exceedingly cheap. These advantages will continue to make the island the chief source of supply for some years to come. It is reported that large fields of sulphur on the island of Saba, one of the Lesser Antilles group of the West Indies, have been purchased by a syndicate composed of Boston and Lowell capitalists, and though the mines are said to be some distance inland, and the cost of mining and transportation to the seaboard will be quite heavy, this expense is warranted by the quantity and purity of the ore.

In a report under date of August 20, 1889, Mr. Vincent Lamantia, United States consul at Catania, island of Sicily, gives some interesting information regarding the sulphur mines of Sicily, from which the following data are

abstracted. There are in all 567 mines on the island, 376 of which were in operation at the time of writing his report. Some of the important mines give employment to as many as 400 men and boys. The wages for men amounts to about 58 cents per day, and for boys about 29 cents, 8 hours being the usual length of a working day. The amount of sulphur exported from the island of Sicily for the years 1850 to 1888, inclusive, and the countries receiving the same are shown in the following tables:

SULPHUR EXPORTED FROM SICILY TO VARIOUS COUNTRIES FROM 1850 TO 1888, INCLUSIVE.

[Short tons.]

YEARS.	Total.	Italy.	Great Britain.	France.	United States.	Other countries.
Total	3,303,948	478,884	744,237	729,555	596,724	754,548
1850	21,426	843	7,170	9,456	1,818	2,139
1851	25,932	1,188	10,419	9,273	1,695	3,357
1852	26,094	1,743	7,353	11,688	1,668	3,642
1853	30,972	174	15,483	10,287	1,173	3,855
1854	38,214	1,131	21,429	8,253	2,211	5,190
1855	33,747	1,221	16,176	12,276	678	3,396
1856	39,894	855	17,889	14,787	1,338	5,025
1857	39,621	897	16,662	18,858	738	2,466
1858	37,227	2,628	17,928	11,322	969	4,380
1859	49,260	2,334	20,301	18,597	3,468	4,560
1860	39,975	2,691	16,809	13,074	2,229	5,172
1861	44,973	3,918	16,446	18,090	603	5,916
1862	63,693	5,757	23,424	18,561	4,326	11,625
1863	75,477	14,511	17,358	22,986	3,132	17,490
1864	69,429	11,754	23,403	21,051	2,379	10,842
1865	70,152	14,454	20,256	16,755	5,682	13,005
1866	70,965	7,245	27,777	16,746	5,688	13,509
1867	78,261	11,040	23,439	17,940	4,245	21,597
1868	73,344	12,132	22,485	18,096	5,859	14,772
1869	73,107	11,766	23,115	14,943	8,034	15,249
1870	78,144	11,124	27,282	12,603	9,627	17,508
1871	80,601	11,844	24,588	14,898	10,227	19,044
1872	91,653	14,487	23,502	22,071	9,654	21,939
1873	99,672	17,046	18,693	21,672	10,362	31,899
1874	85,746	15,081	19,935	13,467	10,461	26,802
1875	101,868	15,075	24,177	14,655	9,555	38,406
1876	92,436	14,430	19,509	12,162	8,943	37,392
1877	98,847	21,504	21,342	16,041	16,773	23,187
1878	109,203	22,887	17,001	20,286	24,633	24,396
1879	132,411	24,036	19,833	31,563	32,697	24,282
1880	136,809	12,960	19,338	31,779	47,166	25,626
1881	133,251	14,019	21,033	28,425	42,720	27,054
1882	136,746	19,584	18,840	21,294	43,263	33,765
1883	150,297	33,072	19,578	30,186	36,510	30,951
1884	148,353	27,903	18,774	30,684	41,829	29,163
1885	148,860	23,925	17,025	26,235	34,947	46,728
1886	159,087	25,152	15,444	26,001	46,188	46,302
1887	150,168	23,580	15,438	27,003	42,273	41,874
1888	167,973	22,893	17,583	25,491	60,963	41,043

SULPHUR EXPORTED FROM SICILY IN 1889.

[Short tons.]

EXPORTED TO—	Total.	From Girjenti.	From Catania.	From Licata.
Total	171,105	71,838	55,659	43,608
United States	53,250	35,436	6,201	11,613
France	32,619	15,810	3,855	12,954
Italy	21,171	2,367	14,994	3,810
Great Britain	18,276	7,995	9,597	684
Other countries	45,789	10,230	21,012	14,547
Total in 1888	167,973	69,276	60,267	38,430

SULPHUR EXPORTS FROM SICILY FOR 10 YEARS, FROM 1879 TO 1888, INCLUSIVE.

	SHORT TONS.
Girjenti	644,543
Catania	555,410
Licata	264,062
Total	1,464,015

COUNTRIES IMPORTING SICILIAN SULPHUR FROM 1879 TO 1888, INCLUSIVE.

	SHORT TONS.
United States	428,556
France	278,661
Italy	227,124
Great Britain	182,886
Other countries	346,788
Total	1,464,015

STATEMENT, BY COUNTRIES AND BY CUSTOMS DISTRICTS, SHOWING THE IMPORTS INTO THE UNITED STATES OF CRUDE SULPHUR OR BRIMSTONE EACH FISCAL YEAR FROM 1876 TO 1889, INCLUSIVE.

[Short tons.]

COUNTRIES WHENCE EXPORTED AND CUSTOMS DISTRICTS THROUGH WHICH IMPORTED.	1876.		1877.		1878.		1879.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRIES	48,966	$1,473,678	43,443	$1,242,788	47,922	$1,173,156	65,919	$1,487,698
Dutch West Indies and Guiana	1,515	15,427						
England	30	1,211	425	14,631	(?)	16	2	335
Scotland	24	910	472	13,231	160	3,961	806	19,287
Gibraltar			290	7,789				
Quebec, Ontario, Manitoba, etc					12	264		
Italy	46,941	1,439,839	41,819	1,194,009	47,494	1,161,367	64,420	1,453,138
Japan	456	16,291	437	13,137	256	7,548	224	4,528
Portugal							467	10,410
DISTRICTS	48,966	1,473,678	43,443	1,242,788	47,922	1,173,156	65,919	1,487,698
Baltimore, Maryland	5,157	157,828	3,882	105,175	5,455	138,202	6,969	157,243
Barnstable, Massachusetts							600	13,783
Boston and Charlestown, Massachusetts	5,031	154,883	3,931	101,215	5,795	131,945	7,841	173,506
Charleston, South Carolina					526	12,267	605	13,812
Delaware, Delaware	450	13,500					899	21,957
Huron, Michigan					12	264		
Newark, New Jersey			1,071	31,802	462	13,240	443	10,175
New Orleans, Louisiana	172	5,705	150	4,750			100	2,987
New York, New York	24,524	721,092	21,867	654,997	28,240	690,989	36,543	827,193
Philadelphia, Pennsylvania	12,549	385,071	9,216	256,224	6,657	167,222	11,704	263,467
Providence, Rhode Island	600	18,232	1,739	45,487	519	11,479		
San Francisco, California	483	17,367	862	27,768	256	7,548	224	4,528
Savannah, Georgia			725	15,370				

COUNTRIES WHENCE EXPORTED AND CUSTOMS DISTRICTS THROUGH WHICH IMPORTED.	1880.		1881.		1882.		1883.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRIES	83,236	$1,927,502	105,438	$2,713,494	97,956	$2,627,402	94,536	$2,288,795
England	1	22					13	379
Scotland	1,664	36,444	1,668	43,311	755	20,294	3	88
France	988	23,580			526	13,770	34	858
French West Indies					2	8		
Greece					500	13,927		
Italy	80,301	1,862,712	102,771	2,645,233	92,944	2,504,862	92,861	2,248,870
Japan	282	4,744	691	16,253	2,980	66,356	1,038	23,714
San Domingo					240	7,875		
Spain			308	8,637			500	12,856
Spanish possessions in Africa and adjacent islands.					9	310	87	2,030
DISTRICTS	83,236	1,927,502	105,438	2,713,494	97,956	2,627,402	94,536	2,288,795
Baltimore, Maryland	13,827	313,342	16,477	430,917	13,781	364,384	11,977	286,438
Beaufort, South Carolina					549	13,889		
Boston and Charlestown, Massachusetts	8,207	183,486	8,860	226,801	7,467	194,317	7,756	173,569
Charleston, South Carolina	1,061	25,398	3,065	78,741	6,025	161,281	4,051	106,235
Middletown, Connecticut					9	310		
New Orleans, Louisiana	289	7,121	100	2,646	220	6,516	428	10,378
New York, New York	46,657	1,083,784	57,608	1,463,082	46,531	1,260,222	45,385	1,110,313
Philadelphia, Pennsylvania	10,679	254,892	17,987	477,547	14,839	408,611	22,772	549,095
Providence, Rhode Island	1,255	31,155	650	17,507	1,244	33,036	535	13,830
Richmond, Virginia					660	17,760		
San Francisco, California	1,270	28,324	691	16,253	6,054	151,234	1,072	24,572
Savannah, Georgia					586	15,842	560	14,365

STATEMENT, BY COUNTRIES AND BY CUSTOMS DISTRICTS, SHOWING THE IMPORTS, ETC.—Continued.

[Short tons.]

COUNTRIES WHENCE EXPORTED AND CUSTOMS DISTRICTS THROUGH WHICH IMPORTED.	1884. (a)		1885.		1886.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRIES	105,143	$2,242,678	96,841	$1,941,943	117,396	$2,237,332
Belgium			190	4,766	60	1,718
England			606	15,084	81	2,535
Quebec, Ontario, Manitoba, and the Northwest Territory						9
Italy			94,370	1,894,858	112,283	2,166,565
Japan			1,541	25,683	4,972	66,505
Spain			134	1,552		
DISTRICTS	105,143	2,242,678	96,841	1,941,943	117,396	2,237,332
Baltimore, Maryland	15,037	303,226	14,595	285,006	19,307	364,958
Barnstable, Massachusetts	650	16,163	480	11,040	1,617	35,385
Beaufort, South Carolina	600	13,259	610	12,847		
Boston and Charlestown, Massachusetts	5,294	112,152	5,125	99,712	3,681	69,898
Champlain, New York						9
Charleston, South Carolina	6,125	132,570	8,525	169,564	13,350	265,265
New Orleans, Louisiana			102	2,282	250	5,102
New York, New York	52,478	1,135,725	45,537	909,123	58,758	1,115,519
Philadelphia, Pennsylvania	18,786	401,468	18,696	381,010	15,568	300,749
Providence, Rhode Island	651	15,517	1,840	37,422	1,265	25,930
San Francisco, California	5,522	112,598	1,421	33,937	3,600	54,517

COUNTRIES WHENCE EXPORTED AND CUSTOMS DISTRICTS THROUGH WHICH IMPORTED.	1887.		1888.		1889.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
COUNTRIES	97,383	$1,688,360	99,253	$1,581,582	130,191	$2,025,644
Belgium			83	1,933	180	4,086
Danish West Indies	861	5,250				
England	162	4,437	310	7,200	305	8,337
France	290	6,951				
Italy	89,924	1,588,146	92,528	1,499,720	123,260	1,935,368
Japan	6,146	83,576	6,332	72,729	6,446	77,853
DISTRICTS	97,383	1,688,360	99,253	1,581,582	130,191	2,025,644
Baltimore, Maryland	12,547	225,669	11,989	182,769	15,791	234,693
Barnstable, Massachusetts	1,152	22,816				
Beaufort, South Carolina			500	9,000	600	9,213
Boston and Charlestown, Massachusetts	4,850	85,575	3,780	62,298	6,446	104,257
Charleston, South Carolina	12,420	220,598	12,005	199,048	23,377	364,859
New Orleans, Louisiana			200	3,845		
New York, New York	46,711	792,114	50,486	816,286	60,922	959,872
Philadelphia, Pennsylvania	15,267	269,216	10,519	173,699	13,288	202,357
Providence, Rhode Island	600	11,291	1,310	21,012	570	8,581
San Francisco, California	3,176	59,521	6,352	78,732	4,539	57,925
Savannah, Georgia					2,345	44,244
Wilmington, North Carolina			1,532	25,893	1,753	28,443
All other customs districts	660	10,569	600	9,000	560	11,200

a Sources not reported.

PRICES.

The price for crude sulphur from 1881 to 1887 showed a steady decline. From $31 per ton for seconds in 1881 it fell to $27.50 at the close of 1882, to $27 in 1883, $23.50 in 1884, $22.40 in 1885, until in 1887 it reached as low as $19.50 for seconds and $19.25 for thirds. The price has continued to range between $19.25 and $21 since that year for seconds and $18 to $19.25 for thirds. The prices at the opening of 1889 were $19.25 and $19.50 for seconds and $18.75 to $19 for thirds. In December the price for seconds was from $19 to $19.50, and for thirds from $18.25 to $18.75. The decline in prices is attributed to the increasing consumption of pyrites for the manufacture of sulphuric acid.

THE CHANCE PROCESS.

Another source of supply in 1889 was the sulphur recovered from alkali works by the Chance process, which converts the sulphur of the waste calcium sulphide into hydrogen sulphide and from this to free sulphur. Some 20 or more alkali works in England have adopted this process, and the resulting sulphur is shipped largely to the United States. The economic value of this discovery is twofold: (1) The foul odors which poisoned the atmosphere in the vicinity of the alkali works and the pollution of running streams are corrected. (2) All of the sulphur used in the process of alkali manufacture goes into this waste. Its recovery by this process means an annual saving of from 180,000 to 200,000 tons. The problem whose solution brings the above result occupied the time and labor of Mr. William Gossage for 30 years. He accomplished a partial success, which was perfected by Mr. A. M. Chance, of Oldbury, England, after 6 years of study. The process, briefly, is as follows: the waste (calcium sulphide), mixed with water, is placed in vessels connected by pipes, and carbonic-acid gas from limekilns is pumped through them. If any free lime be present the carbonic acid immediately combines with it to form calcium carbonate. It also combines in the presence of water with the calcium sulphide, forming calcium carbonate and hydrogen sulphide. Other gases, chiefly nitrogen, are eliminated during the process. The next object is to obtain the sulphur from the hydrogen sulphide. This is effected by the process patented by C. F. Claus by means of what is known as the Claus kiln. The hydrogen sulphide, with proper proportions of air, is passed over anhydrous oxide of iron. The sulphur is liberated while the oxide of iron is kept at a dull red heat by the reaction.

PYRITES.

PYRITES.

BY E. W. PARKER.

PRODUCTION.

The pyrites treated under this report includes only that mined for its sulphur contents and used in the manufacture of sulphuric acid. Pyrites occurs more or less plentifully in almost every state of the Union, but its production during 1889 was limited to 3 states, Massachusetts, New Hampshire, and Virginia. Owing to large stocks on hand and the prevalence of low prices, the New Hampshire mines, located at Copperville, Coos county, were not operated during the calendar year 1889. The product from Massachusetts and Virginia, labor employed at mines, operating expenses, and capital invested are shown in the following tables:

PRODUCTION OF PYRITES IN 1889.

[Short tons.]

STATES.	Quantity.	Value.
Total	104,950	$202,119
Massachusetts	36,350	92,119
Virginia	68,600	110,000

LABOR EMPLOYED AT PYRITES MINES.

STATES.	ABOVE GROUND.											
	Average number employed.				Average wages per day.				Average number of days worked.			
	Foremen.	Mechanics.	Laborers.	Boys under 16 years.	Foremen.	Mechanics.	Laborers.	Boys under 16 years.	Foremen.	Mechanics.	Laborers.	Boys under 16 years.
Total	4	17	65	22	$1.75	$1.59	$1.06	$0.53	287	291	273	235
Massachusetts	1	5	20	3	2.00	2.21	1.25	0.75	300	290	276	276
Virginia	3	12	45	19	1.66	1.33	0.97	0.50	283	292	272	229

STATES.	BELOW GROUND.								
	Average number employed.			Average wages per day.			Average number of days worked.		
	Foremen.	Miners.	Laborers.	Foremen.	Miners.	Laborers.	Foremen.	Miners.	Laborers.
Total	3	75	51	$3.13	$1.55	$1.27	303	185	254
Massachusetts	1	25	16	3.40	2.00	1.80	308	288	288
Virginia	2	50	35	3.00	1.33	1.03	300	133	239

OPERATING EXPENSES.

STATES.	Total expenditures.	Wages.	Office force at mines.	Paid contractors.	Paid for supplies.	Other expenditures.
Total	$163,256	$62,379	$5,512	$23,103	$42,000	$30,262
Massachusetts	63,156	10,379	2,412	23,103	17,000	10,262
Virginia	100,100	52,000	3,100	.....	25,000	20,000

CAPITAL INVESTED.

STATES.	Total.	In land.	Buildings, machinery, etc.	Tools, implements, live stock, etc.	Cash.
Total	$1,358,882	$955,500	$207,000	$149,504	$46,878
Massachusetts	258,882	165,500	47,000	44,504	1,878
Virginia	1,100,000	790,000	160,000	105,000	45,000

SULPHURIC ACID FROM PYRITES.

Considering the liberal manner in which pyrites is distributed throughout the United States and the economy with which sulphuric acid may be prepared from it, it is remarkable that the production of pyrites for this purpose continues comparatively small. For all ordinary purposes, such as the refining of petroleum, the manufacture of fertilizers known as superphosphates, the washing of wool, etc., acid from pyrites serves equally well with that made from brimstone, though for medicinal purposes pyrites acid is objectionable, owing to the fact that it is apt to contain arsenic or other injurious impurities in the ore. The principal reasons for the objection to the use of pyrites given by manufacturers of acid are, first, the changes necessary in the furnaces for roasting the ore, the pyrites requiring to be burned over a grate, and, second, the remoteness of the mines from manufacturing centers and the cost of transportation. A great deal of attention is now being paid to pyrites localities in the country, particularly those in the southern states, and it is to be expected that as these properties are further developed suitable furnaces for the manufacture of acid will be erected at the mines and the trade supplied direct. By this means the cost of transporting the ore will be overcome, and, as experiments have shown that a ton of acid can be more economically prepared from pyrites than from imported brimstone, a decided increase in production may be looked for in the near future. Mr. W. H. Adams, of Mineral City, Virginia, has made the following estimates on the comparative cost of sulphuric acid made from brimstone (imported) and pyrites (computations are made for plants at Atlanta, Georgia):

COST OF SULPHURIC ACID FROM BRIMSTONE AT ATLANTA, GEORGIA.

(One day's work.)

4 tons of brimstone, including cost of freight, losses in transit, etc., at $24 per ton	$96.00
Nitrate of soda, 6 per cent of brimstone used, 538 pounds, at $2.50 per 100 pounds	13.45
Labor, 5 men, at $1.25 per day	6.25
Coal, 2 tons, at $3 per ton	6.00
Superintendent and office cost	6.00
Wear and tear	10.00
Producing 18 tons of chamber acid ($7.65 per ton)	137.70

COST OF SULPHURIC ACID FROM PYRITES AT ATLANTA, GEORGIA.

(One day's work.)

10 tons pyrites, including costs as above, at $5 per ton	$50.00
Nitrate of soda, 400 pounds, at $2.50 per 100 pounds	10.00
Coal	6.00
Labor	6.25
Superintendent and office cost	6.00
Wear and tear	10.00
Producing 18 tons of chamber acid ($4.90 per ton)	88.25

This would seem to be a decided advantage in favor of using pyrites. The advantage of making acid at the mines would appear still more apparent. The cost of mining pyrites and laying it down ready for shipment has been estimated at $1.50 per ton. The production of 104,950 tons of pyrites during the year 1889, at a total cost of $163,256, makes the cost per ton $1.56, showing the estimate to be very near correct. The cost of pyrites in the preceding comparative table is placed at $5 per ton, leaving a difference of $3.44 per ton in favor of manufacture at the mines. These figures would, however, be partly offset by probable additional cost of labor and greater cost of coal and other supplies at points distant from trade centers.

In a contribution to Mineral Resources of the United States for 1886 Mr. Richard P. Rothwell gives the following comparative statements of the cost of producing sulphuric acid from brimstone and pyrites in the districts of New York and Philadelphia:

COMPARATIVE COST OF PRODUCING 1 TON OF SULPHURIC ACID FROM BRIMSTONE AND PYRITES.

BRIMSTONE.	Cost per ton.	PYRITES.	Cost per ton.
Total	$30.60	Total	$25.75
1 ton (2,000 pounds) of brimstone "thirds", 98 per cent sulphur	19.00	2.5 short tons of iron pyrites, 46 per cent sulphur, at 10 cents per unit per ton.	11.50
50 pounds nitrate of soda, at 2.5 cents per pound	1.25	60 pounds nitrate of soda, at 2.5 cents per pound	1.50
5 hundredweight coal, $4 per ton	1.00	5 hundredweight coal, at, say, $4 per ton	1.00
Workmen's wages	2.25	Workmen's wages	3.00
Superintendence and management	2.00	Superintendence and management	2.00
General jobbing repairs	0.50	General jobbing repairs	0.60
Interest on capital of $75,000 (a)	4.60	Interest on capital of $100,000 (a)	6.15
Product 4.5 tons of 50° baumé, cost per ton	6.80	Product 4.5 tons of 50° baumé, cost per ton	5.72

a At 10 per cent per annum, the works being calculated to last only 10 years and to produce during that time 20 tons of acid daily.

SAVING TO BE ACCOMPLISHED IN USING PYRITES.

Aside from the evident economy which the manufacture of acid from pyrites involves for the manufacturer, a saving to the country is to be noted in the amount paid for sulphur to owners of foreign mines. The 104,950 tons of pyrites produced in 1889 replace about 40,000 tons of imported brimstone, or, in other words, exert an annual saving to the country of about $800,000 in cash. Assuming that this quantity of pyrites will produce 180,000 tons of sulphuric acid, it will be seen that there is still a very large demand to be filled. It is estimated that there are about 1,000,000 tons of this acid consumed annually in this country, and its use is constantly increasing and new fields opening. With such a prospect there is no reason to fear that the increased production of pyrites will have any appreciable effect on prices of sulphuric acid.

PRODUCTION IN PREVIOUS YEARS.

The following table shows the production of domestic pyrites from 1882 to 1889, inclusive:

PRODUCTION OF PYRITES IN THE UNITED STATES FROM 1882 TO 1889, INCLUSIVE.

[Long tons.]

YEARS.	Quantity.	Value.
1882	12,000	$72,000
1883	25,000	137,500
1884	35,000	175,000
1885	49,000	220,500
1886	55,000	220,000
1887	52,000	210,000
1888	54,331	167,658
1889	a104,950	202,119

a Short tons.

IMPORTS OF PYRITES CONTAINING NOT MORE THAN 3.5 PER CENT COPPER. (a)

[Long tons.]

YEARS.	Quantity.	Value.
1884	16,710	$50,632
1885	6,078	18,577
1886	1,605	9,771
1887	16,578	49,661

a Previous to 1884 classed among sulphur ores; subsequent to 1887 classed among other iron ores.

MINERAL WATERS.

MINERAL WATERS.

BY ALBERT C. PEALE.

PRODUCTION.

The total value of the production of mineral waters in the United States for the year 1889 was $1,748,458. The total number of gallons sold was 12,780,471, being the production of 258 springs.

No comparison can be made with any previous census returns, as they do not exist, nor can a comparison be made with any state returns of previous years. The accompanying table is the first in which the production has ever been given by states and territories.

In a table on page 781 a comparison is made with the production by geographical divisions from 1883 to 1888, as published in Mineral Resources of the United States. According to this table there was a total increase in 1889 of 3,951,823 gallons over the production of 1888. The increase in value is $189,156. This value, of course, takes no account of the estimate made in 1888 of the springs not reporting, as no account has been taken of the springs delinquent for 1889. The number of springs from which the water is used commercially has increased from a total of 198 in 1888 to 258 in 1889.

In the North Atlantic states there is an increase of 1,249,665 gallons. A decrease of 1,043,148 gallons is reported from the South Atlantic states, while in the North Central states the increase in production for 1889 is 4,135,403 gallons. The South Central states show an increase of 73,590 gallons, and the Western states and territories a decrease of 463,687 gallons.

PRODUCTION OF MINERAL WATERS FOR 1889, BY STATES AND TERRITORIES.

STATES AND TERRITORIES.	Number of springs reporting.	Product. (Gallons.)	Value of product.	Capital invested.	Wages.	Supplies and materials consumed.	All other expenses.
Total	258	12,780,471	$1,748,458	$5,994,683	$433,583	$524,864	$210,304
Alabama	5	24,380	2,430	17,550	760	325	140
Arkansas	3	110,200	10,020	12,525	3,690	1,525	300
California	14	808,625	252,241	590,062	93,991	11,649	3,326
Colorado	8	304,600	87,400	261,311	25,180	51,990	525
Connecticut	3	4,410	2,630	8,000	978	1,000	.....
Georgia	3	31,120	9,412	69,260	1,112	500	250
Illinois	10	2,207,216	38,697	39,210	7,637	10,488	7,632
Indiana	8	125,162	9,525	62,200	3,030	800	170
Iowa	5	12,780	2,490	15,000	2,700	50	1,165
Kansas	9	245,033	15,394	148,400	9,218	3,850	380
Kentucky	5	121,350	14,378	54,000	7,700	600	1,000
Maine	8	888,600	79,060	169,335	41,464	23,796	6,473
Maryland	4	74,160	12,057	95,403	4,758	9,584	9,392
Massachusetts	8	1,011,173	63,622	94,416	16,663	21,758	6,106
Michigan	7	333,345	67,987	135,800	5,778	29,900	6,690
Mississippi	2	8,870	1,174	5,000	500	.....	50
Missouri and Nebraska	14	289,720	23,270	152,395	4,923	1,954	1,394
New Hampshire	2	60,000	4,500	13,000	1,100	300	.....
New Mexico	4	32,700	10,225	92,525	5,059	1,400	500
New York	21	1,795,543	239,875	1,859,250	59,232	54,065	59,112
North Carolina	11	70,644	19,431	66,950	6,599	1,637	3,382
Ohio	11	251,610	26,696	75,890	4,637	3,825	950
Oregon	2	4,800	1,680	102,750	600	.....	250
Pennsylvania	12	275,700	65,163	670,300	18,147	13,650	8,050
Rhode Island	2	47,000	2,975	11,400	1,095	525	100
South Carolina	2	50,520	10,046	41,500	1,310	1,000	2,000
Tennessee	4	21,500	5,000	20,200	1,460	50	200
Texas	14	213,700	10,354	66,440	6,473	2,465	302
Vermont	3	16,150	11,975	8,000	650	275	200
Virginia	22	397,395	141,476	215,450	15,028	41,900	29,295
Washington	3	113,748	14,943	33,200	4,921	4,300	995
West Virginia	4	21,900	5,360	11,000	1,225	275	700
Wisconsin	20	2,292,910	409,179	681,500	61,930	198,821	70,700
Other states (a)	5	513,907	77,793	104,461	14,044	30,607	6,575

a Florida, Idaho, Minnesota, New Jersey, and South Dakota.

IMPORTS.

Prior to 1884 the Treasury department did not distinguish natural mineral waters from those that were artificial. Since 1883 the distinction has been made, but the artificial waters have not been classified according to the receptacles in which they have been imported. The importation is shown in the 2 tables following, with a table of exports appended.

MINERAL WATERS IMPORTED INTO THE UNITED STATES FROM 1867 TO 1883, INCLUSIVE.

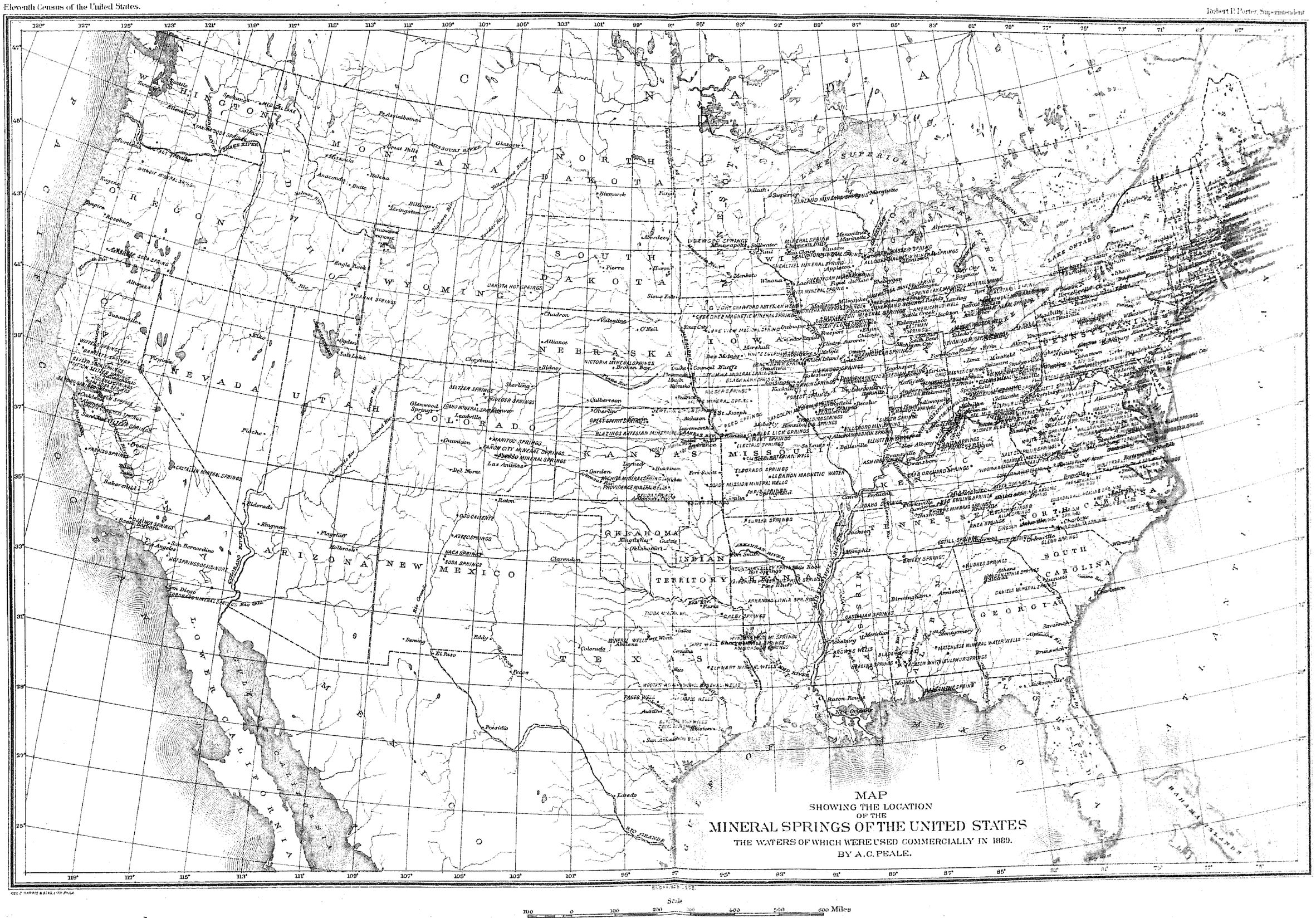
YEARS ENDED—	Total.	IN BOTTLES OF ONE QUART OR LESS.		IN BOTTLES IN EXCESS OF ONE QUART.		NOT IN BOTTLES.		ALL, NOT ARTIFICIAL.	
		Quantity. (Bottles.)	Value.	Quantity. (Quarts.)	Value.	Quantity. (Gallons.)	Value.	Quantity. (Gallons.)	Value.
June 30, 1867	$25,410	370,610	$24,913	3,792	$360	.....	$137	.....	.....
1868	20,594	241,702	18,438	22,819	2,052	554	104	.....	.....
1869	26,682	344,691	25,635	9,739	802	1,042	245	.....	.....
1870	32,931	433,212	30,680	18,025	1,743	2,063	508	.....	.....
1871	34,919	470,947	34,604	2,320	174	1,336	141	.....	.....
1872	68,067	892,913	67,951	.....	.....	639	116	.....	.....
1873	100,552	35,508	2,326	.....	.....	355	75	394,423	$98,151
1874	80,496	7,238	691	.....	.....	95	16	199,035	79,789
1875	102,113	4,174	471	.....	.....	5	2	395,956	101,640
1876	136,788	25,758	1,899	.....	.....	.....	.....	447,646	134,889
1877	168,808	12,965	1,328	.....	.....	.....	22	520,751	167,458
1878	351,727	8,229	815	.....	.....	.....	.....	883,674	350,912
1879	284,509	28,440	2,352	.....	.....	3	4	798,107	282,153
1880	305,529	207,554	19,731	.....	.....	.....	.....	927,759	285,798
1881	395,492	150,326	11,850	.....	.....	55	26	1,225,462	383,616
1882	427,115	152,277	17,010	.....	.....	.....	.....	1,542,905	410,105
1883	448,493	88,497	7,054	.....	.....	.....	.....	1,714,085	441,439

IMPORTS FOR THE YEARS 1884 TO 1888, INCLUSIVE.

YEARS ENDED—	ARTIFICIAL MINERAL WATERS.		NATURAL MINERAL WATERS.	
	Gallons.	Value.	Gallons.	Value.
June 30, 1884	29,366	$4,591	1,505,298	$362,651
1885	7,972	2,157	1,660,072	397,875
Dec. 31, 1886	62,464	16,815	1,618,960	354,242
1887	13,885	4,851	1,915,511	385,906
1888	12,752	4,411	1,716,461	341,695

VALUE OF EXPORTS OF NATURAL MINERAL WATERS FROM THE UNITED STATES.

Years ended June 30—		Years ended June 30—	
1875	$162	1881	$1,029
1876	80	1882	421
1879	1,529	1883	459
1880	1,486	1884, 1885, 1886, 1887, and 1888	None.


MAP
SHOWING THE LOCATION
OF THE
MINERAL SPRINGS OF THE UNITED STATES
THE WATERS OF WHICH WERE USED COMMERCIALLY IN 1869.
BY A.C. PEALE.
Scale
100 0 100 200 300 400 500 600 Miles
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
INDIAN TERRITORY
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
MAINE
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ONTARIO
GULF OF MEXICO
BAHAMA ISLANDS
GEO. C. HARRIS & BRO. LITH. PHILA.

PRODUCTION BY GEOGRAPHICAL DIVISIONS OF NATURAL MINERAL WATERS SOLD FROM 1883 TO 1888, INCLUSIVE.

GEOGRAPHICAL DIVISIONS.	Springs reporting.	Gallons sold.	Value.	GEOGRAPHICAL DIVISIONS.	Springs reporting.	Gallons sold.	Value.
1883.				1886.			
North Atlantic	38	2,470,670	$282,270	North Atlantic	49	2,715,050	$177,969
South Atlantic	27	312,090	64,973	South Atlantic	38	729,397	123,517
North Central	37	1,435,809	323,600	North Central	40	2,048,914	491,861
South Central	21	1,441,042	139,973	South Central	31	822,016	58,222
Western	6	169,812	52,787	Western	14	781,540	137,796
	129	5,829,423	863,603		172	7,087,917	899,365
Estimated	60	1,700,000	256,000	Estimated	53	1,862,400	384,705
Total	189	7,529,423	1,119,603	Total	225	8,950,317	1,284,070
1884.				1887.			
North Atlantic	38	3,345,760	328,125	North Atlantic	40	2,571,004	213,210
South Atlantic	27	464,718	103,191	South Atlantic	34	614,041	147,149
North Central	37	2,070,533	420,515	North Central	38	1,480,820	208,217
South Central	21	1,526,817	147,112	South Central	29	741,080	87,946
Western	6	307,500	85,200	Western	12	1,236,324	288,737
	129	7,715,328	1,084,143		153	6,643,269	945,259
Estimated	60	2,500,000	375,000	Estimated	62	1,616,340	316,204
Total	189	10,215,328	1,459,143	Total	215	8,259,609	1,261,463
1885.				1888.			
North Atlantic	51	2,527,310	192,605	North Atlantic	42	2,856,799	247,103
South Atlantic	32	908,692	237,153	South Atlantic	32	1,689,387	493,489
North Central	45	2,925,288	446,211	North Central	38	2,002,373	325,839
South Central	31	540,436	74,100	South Central	19	426,410	71,215
Western	10	509,675	86,776	Western	15	1,853,679	421,651
	169	7,411,401	1,036,845		146	8,828,648	1,559,302
Estimated	55	1,737,000	276,000	Estimated	52	750,000	120,000
Total	224	9,148,401	1,312,845	Total	198	9,578,648	1,679,302

PRODUCTION OF NATURAL MINERAL WATERS SOLD IN 1889.

GEOGRAPHICAL DIVISIONS.	Springs reporting.	Gallons sold.	Value.
Total	258	12,780,471	$1,748,458
North Atlantic	60	4,106,464	471,575
South Atlantic	47	646,239	198,032
North Central	86	6,137,776	604,238
South Central	33	500,000	43,356
Western	32	1,389,992	431,257

GEOGRAPHICAL DISTRIBUTION.

The accompanying map shows the location of those springs in the United States the waters of which are used commercially. It will be observed that the waters put upon the market are more numerous from the eastern half of the country. This is not because there are more springs in that section, but mainly because the greatest proportion of population is found there, and, consequently, it is more thoroughly developed as to the utilization of its resources.

The following table shows the rank of the various states according to the number of springs and production in each state:

RANK OF VARIOUS STATES ACCORDING TO NUMBER AND PRODUCTION OF SPRINGS.

STATES AND TERRITORIES.	Rank according to number of springs.	Rank according to production.	STATES AND TERRITORIES.	Rank according to number of springs.	Rank according to production.	STATES AND TERRITORIES.	Rank according to number of springs.	Rank according to production.
Alabama	No. 12	No. 28	Maine	No. 10	No. 5	Ohio	No. 7	No. 13
Arkansas	No. 14	No. 20	Maryland	No. 13	No. 21	Oregon	No. 15	No. 36
California	No. 4	No. 6	Massachusetts	No. 10	No. 4	Pennsylvania	No. 6	No. 12
Colorado	No. 10	No. 10	Michigan	No. 11	No. 9	Rhode Island	No. 15	No. 25
Connecticut	No. 14	No. 37	Minnesota	No. 16	No. 8	South Carolina	No. 15	No. 24
Florida	No. 16	No. 38	Mississippi	No. 15	No. 34	South Dakota	No. 16	No. 33
Georgia	No. 14	No. 27	Missouri	No. 5	No. 11	Tennessee	No. 13	No. 30
Idaho	No. 16	No. 16	Nebraska	No. 16		Texas	No. 4	No. 15
Illinois	No. 8	No. 2	New Hampshire	No. 15	No. 23	Vermont	No. 14	No. 31
Indiana	No. 10	No. 17	New Jersey	No. 16	No. 35	Virginia	No. 1	No. 7
Iowa	No. 12	No. 32	New Mexico	No. 13	No. 26	Washington	No. 14	No. 19
Kansas	No. 9	No. 14	New York	No. 2	No. 3	West Virginia	No. 13	No. 29
Kentucky	No. 12	No. 18	North Carolina	No. 7	No. 22	Wisconsin	No. 3	No. 1

Inasmuch as mineral waters derive their solid contents from the rocks through which they pass on their way to the surface, when they appear as springs, there is an intimate connection between them and the geological structure of the country in which they are found, and a comparison of the map on which the springs are plotted with a geological map of the same region is very instructive. In regions where the older or metamorphic rocks form the surface, or are near to it, the waters as a rule contain a smaller proportion of solid ingredients than where they have to pass through strata that are more readily affected by their solvent powers, thus giving an explanation of the differences between the waters of various sections of the country. The connection of warm and hot springs with mountain elevations and fractures and dislocations of the strata and with areas in which eruptive rocks prevail has frequently been noted, and it is therefore not surprising to find this group of springs so largely in excess of cold springs in the western part of the United States, where large areas covered by flows of basaltic and trachytic rocks prevail.

CLASSIFICATION.

In the first place, all waters are characterized by their temperature, as cold, tepid, warm, or hot. They are therefore divisible into 2 great groups, nonthermal and thermal.

The term thermal is not used here as applying to springs whose temperature is above the mean annual temperature of the place in which they are located, but included under this designation are those springs the waters of which have a temperature of 70° fahrenheit or more. A thermal spring may belong to any one of the classes or divisions which are based on the predominating solid constituents.

The fact that a spring is thermal depends mainly upon its geological position. Warm and hot springs are found in regions of volcanic rocks, in connection with faulted or dislocated strata, in areas of mountain corrugation, or where borings have been made to great depths below the surface. It has frequently been stated that thermal springs are less highly mineralized than others, but facts do not sustain this statement. They are less numerous, but there appears to be no reason why they may not duplicate nonthermal springs in every particular except temperature. Each group of waters is next divided into 4 classes, viz, alkaline, alkaline-saline, saline, and acid.

The term "indifferent" or "chemically indifferent" of many schemes of classification has not been used. The question as to whether a water should be called indifferent is one upon which it would be difficult to secure unanimous opinion. The spring owner would perhaps draw his line at one place, the physician who prescribes the water might draw it at another, and the chemist at still a third place.

The analyses should therefore be arranged in order according to the proportion of the classifying ingredient, beginning with the least highly mineralized water under each division, and it seems preferable that the lines of indifference be drawn by those especially interested. Pure water is a production of the chemical laboratory alone. No chalybeate waters are placed on a line with alkaline or saline waters. Of course, all iron waters are tonic in their effects, but they may differ widely in other properties. When the various analyses of chalybeate springs are compared, it is found that those in which iron exists as a carbonate contain also carbonates of the alkalies or alkaline earths. Others contain iron sulphates with various other sulphates, or they may be characterized by chlorides. Others again have free acid with the saline constituents. The chalybeates therefore, it seems, should be subdivisions of the alkaline, alkaline-saline, saline, and acid classes, and here they are placed in this scheme. The fact that they all contain iron should not relegate them to one class, especially when their effects may be widely different. The other ingredients must not be ignored.

Almost the same remarks hold good for the sulphur springs that have been made in regard to the chalybeate springs. Sulphur springs are those in which free sulphureted hydrogen exists; that is, they have a gaseous constituent. A very little sulphureted hydrogen will go a great way in classifying a spring, but there is no more reason to disregard the solid constituents here than in the case of the chalybeates. Even the chalybeates may be sulphureted, and in fact any division of the 4 classes outlined may contain the same gaseous constituent.

The waters are therefore characterized finally according to the gas they contain. They may be nongaseous, carbonated, sulphureted, carbureted, or azotized (that is, containing nitrogen gas).

It may be objected that the sulphur springs are separated one from the other; but if necessary the scheme can be reversed and the gaseous character indicated first. If this be done, the alkaline, saline, and acid springs must be divided up and separated. The plan adopted here is more compact. It seems preferable to keep all the alkaline waters, etc., together, particularly as the analyses are not nearly so complete with reference to the gaseous constituents as they are in regard to the solid constituents. Many waters lose the gases long before the water is analyzed in the laboratory, and therefore frequently no account is taken of them beyond the mention of their existence.

In nearly all lithia waters the amount of lithia is relatively small, and very often consists only of traces, so that the springs are classified by some other ingredient. However, the fact that the water contains lithia, even if only a trace, will probably be expressed in the name given to the spring. In making these remarks, of course, nothing is said as to the efficacy or nonefficacy of even the traces in some of the waters. What is true of the lithia waters is true of many others which are supposed to be particularly efficacious in certain diseases. In no scheme of classification can account be taken of all the minor constituents. It is impossible to express all the shades of difference, and in the examination of the analyses with a view to the use of the water a process of exclusion or elimination will have to be followed in order to get the water just suited to the peculiar conditions presented.

Returning now to the scheme outlined, the first class is alkaline. This name has been so long and universally used to include those waters that contain the alkaline carbonates that it is retained. Included under it are all waters characterized by carbonates, whether of the alkalies, alkaline earths, alkaline metals, or even of iron alone, for as already noted, the carbonate of iron is usually associated with alkaline carbonates. The alkaline waters as thus designated are divided primarily into five great divisions, viz, sodic, potassic, calcic, magnesic, and chalybeate, in which the carbonates of sodium, potassium, calcium, magnesium, and iron, respectively, predominate. Those springs are also separated in which there is a combination, as calcic-chalybeate, sodic-magnesic, etc., and they may also have a combination of two or more of the gases, as sulphocarbonated, etc.

Some few springs contain a large quantity of free nitrogen gas. These are designated as azotized. In others the predominating gas is carbureted hydrogen; that is, they are carbureted. For those springs characterized by free carbonic-acid gas the term carbonated instead of acidulous is used to avoid confusion with acid springs. There are carbonated acid sulphated springs, that is, springs with free sulphuric acid, sulphates, and free carbonic-acid gas; and to call these springs acidulous acid springs would be, to say the least, somewhat awkward.

Nearly one-half of the alkaline springs are calcic-alkaline; that is, with calcium carbonate or bicarbonate predominating. The calcic-chalybeate springs come next in number. A great many of the well-known springs fall under the head of calcic-alkaline, such as the Waukesha springs of Wisconsin, the Poland spring of Maine, the Hot springs of Virginia, etc. The lists following give the springs arranged according to total solid contents.

The next class includes the alkaline-saline springs, viz, those in which there is a mixture of carbonates with sulphates or chlorides. It is separated, therefore, into two divisions, sulphated and muriated, according to the predominance of either set of salts, and, secondly, subdivided exactly as were the alkaline springs, according to the base, into the sodic, potassic, magnesic, chalybeate, etc. Each one of these subdivisions may also be nongaseous, carbonated, or sulphureted, etc. The most prominent springs under the head of alkaline-saline are the Saratoga springs, which are placed under the head of carbonated sodic-muriated alkaline-saline springs, that is, they contain free carbonic-acid gas and have sodium chloride predominating, and contain also alkaline carbonates. Naturally the sodic-muriated springs are the most numerous in this class.

The third class, saline springs, is divided exactly as are the alkaline-saline springs. The salines outnumber the alkaline-salines in the proportion of three to one, and are nearly one-third more numerous than the alkaline springs. Almost all of the springs usually classed under the head of purgative or aperient saline will fall under the head of sulphated salines in this scheme.

Thus a sodic-sulphated water and a magnesic-sulphated water would not be mistaken for anything else than purgative waters. Among other waters of this division are many springs well-known all over the country.

About one-quarter of all the sulphated salines in the country are calcic. Possibly in arranging these waters the proportion of the other sulphates ought also to be given, as the calcic-sulphate is supposed to be inert medicinally. Sharon springs, New York, would be placed under the head of sulphureted calcic-magnesic sulphated waters, and some of the Richfield springs belong there also. Possibly they should be called sulphocarbonated, although the sulphureted hydrogen largely predominates. A large number of the alum springs fall under the chalybeate-sulphated springs. Those with free sulphuric acid, however, belong to the acid class.

Of the muriated saline springs nearly 88 per cent are sodic-muriated; that is, with common salt as the principal constituent. Of course, all brines fall under this head.

The fourth and last class is named acid, a class that has been neglected in most schemes of classification. Here under the sulphated-acid division are placed those waters characterized by the presence of free sulphuric acid and sulphates. They include the sour springs found at many localities in Texas, the Oak Orchard acid springs of New York, the Blossburg springs of Pennsylvania, the Iowa acid springs, and most of the alum springs of Virginia and Kentucky, those of Virginia being most numerously found in the markets. The muriated-acid springs are those characterized by the presence of free hydrochloric acid in connection with chlorides.

The foregoing remarks apply to the mineral springs of the country as a whole, and in the following attempt to classify the commercial natural mineral waters of the United States in accordance with the scheme outlined, only the springs actually reporting sales are included.

SCHEME OF CLASSIFICATION OF NATURAL MINERAL WATERS.

	GROUP A.—NONTHERMAL.	GROUP B.—THERMAL.
Class I. Alkaline.		
Class II. Alkaline-saline	1. Sulphated.	1. Sulphated.
	2. Muriated.	2. Muriated.
Class III. Saline	1. Sulphated.	1. Sulphated.
	2. Muriated.	2. Muriated.
Class IV. Acid	1. Sulphated.	1. Sulphated.
	2. Muriated.	2. Muriated.
	3. Siliceous { a Sulphated.	3. Siliceous { a Sulphated.
	{ b Muriated.	{ b Muriated.

The commercial waters following are not noted as belonging to either Group A or Group B, as when placed upon the market they are practically nonthermal, whether they are considered as thermal or nonthermal at the spring furnishing the water.

Many of the springs in this list would be indicated in some systems of classification as "indifferent", but the line of indifference is one that would be drawn at very different places by different persons, according to their points of view. Therefore, the total solid contents of the waters are given and each one interested can draw the line.

I. ALKALINE SPRINGS.	GRAINS PER GALLON.
SODIC:	
Pavilion springs, Pennsylvania	1.98
Medical lake, Washington	101.46
CARBONATED SODIC:	
Corry artesian fountain, Pennsylvania	20.59
Bladen springs, Alabama	48.88
Geyser Soda spring, California	57.12
El Toro spring, California	187.15
Litton Seltzer spring, California	228.69
Joseph's Ojo Caliente springs, New Mexico	1,686.34
SULPHURETED SODIC:	
Allegheny Sulphur springs, Pennsylvania	24.20
SODIC-CALCIC:	
Ashley's Bromine and Arsenic spring, Tennessee	4.82
CARBONATED SODIC-CALCIC:	
Navajo spring, Manitou Springs, Colorado	25.33
Ute spring, Manitou Springs, Colorado	97.49
SODIC-CHALYBEATE:	
Cold Bowling spring, Maine	1.60
Bailey springs, Alabama	14.88
CARBONATED SODIC-CHALYBEATE:	
Panacea springs, North Carolina	9.79
Iron Ute springs, Manitou, Colorado	210.87
CALCIC-ALKALINE:	
Undine spring, Massachusetts	0.27
Arcadian Mineral spring, Waukesha, Wisconsin	0.36
Mineral Rock spring, Waukesha, Wisconsin	0.38
Sheep Rock spring, Massachusetts	0.81
Old Point Indian spring, Maine	2.80
Pæonian spring, Virginia	3.57
Belmont Natural spring, Massachusetts	3.69
Poland spring, Maine	3.75
All Healing spring, North Carolina	7.31
Chattolanee spring, Maryland	8.29

CALCIC-ALKALINE—Continued.	GRAINS PER GALLON.
Echo Grove Mineral spring, Massachusetts	8.41
Ochee spring, Rhode Island	8.99
Lincoln Lithia spring, North Carolina	10.65
Inglewood spring, Minnesota	16.56
Horeb Mineral springs, Waukesha, Wisconsin	20.02
Bellbrook Magnetic spring, Massachusetts	26.79
Mountain Valley spring, Arkansas	21.82
Lake View Medical spring, Iowa	32.28
Clysmic spring, Waukesha, Wisconsin	35.46
Hygeia spring, Waukesha, Wisconsin	36.21
Glen Flora Mineral spring, Illinois	36.41
Bethesda spring, Waukesha, Wisconsin	35.71
White Rock Mineral spring, Waukesha, Wisconsin	37.06
Kickapoo Magnetic springs, Indiana	41.91
Lenape Magnetic spring, Ohio	55.70
Electric Magnetic springs, Ohio	61.33
CARBONATED CALCIC:	
Hot springs, Virginia	0.60
Roscommon spring, Pennsylvania	1.21
Sweet spring, Bedford Springs, Pennsylvania	1.62
Aztec springs, New Mexico	2.83
Crystal springs, Yates county, New York	12.08
Capon springs, West Virginia	12.15
Large Limestone spring, Bedford Springs, Pennsylvania	14.70
Manitou spring, Manitou Springs, Colorado	18.20
Wolf Trap Lithia springs, Virginia	19.83
Massanetta Mineral spring, Virginia	25.76
Electric springs, Missouri	41.73
Bartlett springs, California	43.35
SULPHOCARBONATED CALCIC:	
Roanoke Red Sulphur springs, Virginia	5.21
Spring No. 2 (sulphur spring), Stribling Springs, Virginia	34.88

	GRAINS PER GALLON.
CALCIC-MAGNESIC:	
Shealtiel Mineral springs, Wisconsin	14.65
Henk Mineral spring, Waukesha, Wisconsin	14.65
Nee-Ska-Ra spring, Wisconsin	29.59
Lebens Wasser spring, Wisconsin	31.22
Darlington Mineral spring, Wisconsin	31.79
Salvador Mineral spring, Wisconsin	33.03
Alma spring, Waukesha, Wisconsin	33.35
Vita Mineral spring, Wisconsin	34.06
Perry springs, Illinois	38.24
Ashland spring, Wisconsin	43.69
Allouez Magnesia Mineral spring, Wisconsin	62.38
CARBONATED CALCIC-MAGNESIC:	
Bear Lithia springs, Virginia	9.60
Otterburn Lithia and Magnesic spring, Virginia	9.86
Lebanon Magnetic spring, Missouri	10.72
Eastman springs, Michigan	18.04
Osceola Lithia spring, Virginia	34.39
Ohio Magnetic springs, Ohio	44.90
Idanha spring, Idaho	152.14
SULPHOCARBONATED CALCIC-MAGNESIC:	
Cove Lithia spring, Virginia	10.61
CALCIC-CHALYBEATE:	
Shaw's Healing springs, North Carolina	8.40
Park's Alkaline spring, North Carolina	14.93
CARBONATED CALCIC-CHALYBEATE:	
Chalybeate springs, Stribling Springs, Virginia	20.95
Reed's Mineral springs, Missouri	26.38
CARBONATED MAGNESIC:	
Susquehanna spring, Pennsylvania	9.92
Farmville Lithia springs, Virginia	26.39
Napa Soda springs, California	68.76
Wagner Soda spring, Oregon	163.87
MAGNESIC CHALYBEATE:	
Keystone spring, Maine	3.00
Windsor Chalybeate spring, Maine	5.60
CARBONATED CHALYBEATE:	
Maine fountain, Rawley springs, Virginia	5.78
Cherokee Magnetic Mineral spring, Iowa	29.93
SULPHOCARBONATED CHALYBEATE:	
Chalybeate spring, Eureka Mineral Springs, Pennsylvania	42.35

II. ALKALINE-SALINE SPRINGS.

1. SULPHATED.

CARBONATED SODIC:	
Ponemah springs, New Hampshire	3.03
SODIC-MAGNESIC:	
Idaho Hot springs, Colorado	177.69
CALCIC:	
Allandale spring, Massachusetts	3.30
CARBONATED CALCIC:	
William's spring, Paris Chalybeate Springs, Missouri	1.10
Hartfort Cold spring, Maine	44.68
Spring No. 2, Buffalo Lithia Springs, Virginia	98.38
Shoshone spring, Manitou Springs, Colorado	132.80
Little Chief spring, Manitou Springs, Colorado	132.80
CALCIC-SODIC CHALYBEATE:	
Topeka Mineral wells, Kansas	147.45
CALCIC-MAGNESIC:	
Virginia Arsenic Bromine and Lithia spring, Virginia	18.37
Victoria Mineral springs, Nebraska	62.18
SULPHURETED CALCIC-MAGNESIC:	
Sharon springs, New York:	
Gardner Magnesia spring	127.61
Magnesia spring	132.70
White Sulphur spring	149.10
SULPHOCARBONATED CALCIC-MAGNESIC CHALYBEATE:	
Kirkwood Mineral spring, Illinois	22.28
CARBONATED CALCIC-CHALYBEATE:	
Spring No. 3, Buffalo Lithia spring, Virginia	14.47

2. MURIATED.

	GRAINS. PER GALLON.
SODIC:	
Underwood spring, Maine	2.10
Bowden Lithia spring, Georgia:	
Bromine Lithia spring	173.37
Bowden Lithia spring	191.10
Iron Duke, Cañon City Springs, Colorado	219.54
Little Ute, Cañon City Springs, Colorado	242.95
Castalian mineral water, California	4,422.25
CARBONATED SODIC:	
Willhoit spring, Oregon	421.97
Saratoga Springs, New York:	
White Sulphur	115.73
Magnesic	216.05
Imperial	269.20
Vichy	315.18
New Putnam	361.01
Columbia	407.30
Peerless	419.62
Excelsior	514.75
Patterson	518.18
High Rock	628.04
Royal	640.03
Empire	680.44
Congress	700.89
Union	701.17
Carlsbad	1,149.21
Champion	1,195.58
Magnesia spring, Cresson Springs, Pennsylvania	6.88
De Profundis spring, Eureka Mineral Springs, Pennsylvania	23.77
Pacific Congress spring	335.85
Lansing Magnetic well, Michigan	613.77
Pulaski Mineral spring, Pennsylvania	265.49
SULPHURETED SODIC:	
Triplet Natural Mineral springs, West Virginia	77.88
SULPHOCARBONATED SODIC:	
Coronado springs, California	26.29
White Sulphur spring, Byron Springs, California	36.06
SODIC-POTASSIC	
Kalium springs, New Jersey	5.70
SODIC-MAGNESIC:	
Aspinock spring, Connecticut	2.21
CARBONATED SODIC-MAGNESIC:	
Azule Mineral well, California	153.77
Bedford Magnesic spring	153.87
CALCIC:	
Holly spring, Rhode Island	2.51
Everett Crystal spring, Massachusetts	13.63
CALCIC-SODIC:	
Baca springs, New Mexico	137.44
CARBONATED CALCIC-SODIC:	
Soda springs, New Mexico	153.84

III. SALINE SPRINGS.

1. SULPHATED.

SODIC:	
Black Hawk springs, Illinois	3.99
Paraiso spring, California	58.80
Faris Magnetic well, Pueblo, Colorado	62.03
Palo Pinto Mineral wells, Texas	226.23
Haupt's Mineral spring, Missouri	351.39
Ottumwa Medical springs, Iowa	356.45
CARBONATED SODIC:	
Clarendon springs, Vermont	5.76
Page's well, Texas	378.90
SODIC-CALCIC:	
Magnetic springs and well, Michigan	85.20
SODIC-CHALYBEATE:	
Stafford Mineral spring, Connecticut	5.58

	GRAINS PER GALLON.
CARBONATED SODIC-CHALYBEATE:	
Seltzer Mineral spring, Colorado	293.72
SULPHURETED POTASSIC-SODIC:	
Alburgh springs, Vermont	38.00
CALCIC:	
Daniel Mineral spring, Georgia	108.61
Flintstone Mineral springs, Maryland	174.00
Providence Mineral well, Kansas	246.30
CARBONATED CALCIC:	
Barium springs, North Carolina	8.40
Manhattan Artesian Mineral wells, Kansas	117.94
SULPHURETED CALCIC:	
Glen springs, South Carolina	97.55
Massena Sulphur springs, New York	104.72
CALCIC-SODIC:	
Dakota Hot springs, South Dakota	58.33
SULPHOCARBONATED CALCIC-SODIC MAGNESIC:	
Salt Sulphur springs, West Virginia	200.20
CALCIC-MAGNESIC:	
Hughes springs, Georgia	86.42
Geneva Magnetic Mineral springs, New York	152.01
CARBONATED CALCIC-MAGNESIC:	
Magnesia spring, Bedford Springs, Pennsylvania	141.17
Magnesia Iron spring, Bedford Springs, Pennsylvania	153.30
SULPHURETED CALCIC-MAGNESIC:	
Blue Ridge springs, Virginia	159.66
SULPHOCARBONATED CALCIC-MAGNESIC:	
Greenbrier White Sulphur springs, Virginia	129.66
CALCIC-MAGNESIC CHALYBEATE:	
Iron spring, Cresson Springs, Pennsylvania	108.39
SULPHOCARBONATED MAGNESIC CHALYBEATE:	
Spring No. 1, West Eldorado Springs, Missouri	13.82
CALCIC ALUMINO-MAGNESIC CHALYBEATE:	
Seven springs, Abingdon, Virginia	99.76
CHALYBEATE:	
Matchless Mineral Water well, Alabama	601.62
CARBONATED CHALYBEATE-SODIC MAGNESIC:	
Spring No. 5, West Eldorado Springs, Missouri	9.63
Spring No. 6, West Eldorado Springs, Missouri	25.69
CARBONATED CHALYBEATE-CALCIC MAGNESIC:	
Spring No. 2, Eldorado Springs, Missouri	24.66
Spring No. 4, Eldorado Springs, Missouri	29.31
CARBONATED CHALYBEATE-MAGNESIC:	
Spring No. 3, Eldorado Springs, Missouri	22.01

2. MURIATED.

SODIC:	
Black Hawk springs, Iowa	34.10
Cantonment spring, Florida	42.88
Prairie du Chien Artesian well, Wisconsin	137.03
Saint Patrick's well, Kentucky	165.38
Randolph springs, Missouri	340.12
Tolenas springs, California	360.00
Spring Lake Magnetic well, Michigan	628.37
Sheboygan Mineral spring, Wisconsin	657.88
CARBONATED SODIC:	
Diamond Mineral spring, Colorado	104.90
Sanicula springs, Illinois	170.77
Oneita springs, New York	183.77
Salutaris springs, Michigan	222.20
White Sulphur springs, Iowa	296.49
Deep Rock springs, New York	559.18
Great Spirit spring, Kansas	1,120.76
Byron springs:	
Iron Pipe spring	668.14
Hot Salt spring	706.94
CARBONATED SODIC—Continued.	
Byron springs—Continued.	
Liver and kidney spring	769.05
Surprise spring	18,773.73
SULPHURETED SODIC:	
Lodi Artesian well, Indiana	672.45
Ypsilanti Mineral well, Michigan	1,205.69
Mineral well, Mount Clemens mineral springs, Michigan	13,654.33
Sweet springs, Missouri:	
Sweet spring	152.27
Akesion spring	1,061.94
SULPHOCARBONATED SODIC:	
Ripley Bromo Lithia springs, Ohio	75.17
Rex Mineral spring, Ohio	130.02
Magnetic Mineral springs, Terre Haute, Indiana	429.44
Black Sulphur spring, Byron's Springs, California	461.97
Lower Blue Lick springs, Kentucky	632.83
Iron Spring, Byron's Springs, California	765.64
Spring No. 2, Blue Lick Springs, Missouri	1,213.72
Young's Medicinal wells, Missouri	1,562.01
CARBONATED-AZOTIZED SODIC:	
West Baden springs, No. 1, Indiana	282.99
SODIC-CALCIC:	
Parker Magnetic Mineral spring, Pennsylvania	627.59
SODIC-CALCIC MAGNESIC:	
Arkansas Lithia spring, Arkansas	67.79
CALCIC:	
Simpson springs, Massachusetts	2.60
SULPHURETED CALCIC-SODIC:	
Devonian Mineral spring, Ohio	6,472.21
CARBONATED CALCIC-CHALYBEATE:	
Maryland Strontia spring, Maryland	74.76
SULPHOCARBONATED POTASSIC:	
Peoria Magnetic Artesian springs, Illinois	185.00

IV. ACID SPRINGS.

1. SULPHATED.

ALUMINO-CHALYBEATE:	
Alum spring, Stribling Springs, Virginia	55.86
Black Mountains Iron and Alum spring, North Carolina	99.65
CARBONATED ALUMINO-CHALYBEATE:	
Rockbridge Alum springs, Virginia:	
Chalybeate	7.61
Spring No. 6	17.94
Spring No. 5	21.53
Spring No. 4	27.09
Spring No. 1	43.09
Spring No. 8	52.73
Spring No. 9	55.09
Spring No. 3	61.77
Spring No. 2	62.35
Spring No. 7	116.27
Wallawhatoola Alum springs, Virginia	119.41
ALUMINO-MAGNESIC CHALYBEATE:	
Elkhart Mineral wells, Texas:	
Well No. 2	143.81
Well No. 3	169.28
Well No. 1	181.51
ALUMINO-CALCIC CHALYBEATE:	
Overall Mineral wells, Texas:	
Well No. 1	133.76
Well No. 2	235.01
CALCIC-ALUMINO-MAGNESIA CHALYBEATE:	
Texas Sour springs, Texas	443.91
CALCIC-MAGNESIC CHALYBEATE:	
Brown's wells, Mississippi	266.23

UNCLASSIFIED WATERS.

The following list includes all those springs which either did not furnish an analysis or of which the analysis was only partial or qualitative:

Healing Springs, Alabama.
Jackson White Sulphur Springs, Alabama.
Fairchild's Potash Sulphur Springs, Arkansas.
Hot Springs of Elsinore, California.
Ojai Hot Springs, California.
Boulder Spring, Colorado.
Clark Magnetic Mineral Spring, Colorado.
Hillsboro Mineral Spring, Illinois.
Red Avon Springs, Illinois.
Silver Springs Mineral Well, Illinois.
Ash Iron Spring, Indiana.
Buffalo Saline Well, Indiana.
Elliot's Mineral Springs, Indiana.
King Mineral Spring, Indiana.
Boiling Springs, Kansas.
Geuda Mineral Springs, Kansas.
Osage Mission Mineral Well, Kansas.
Wichita Mineral Water Springs, Kansas.
Anita Springs, Kentucky.
Bedford Springs, Kentucky.
Seal Rock Spring, Maine.
Cecil Spring, Maryland.
Belmont Hill Spring, Massachusetts.
Zauber Wasser Well, Hudson, Michigan.
Artesian White Sulphur Well, Chester, Missouri.
Reiger Springs, Missouri.
Empire Seneca Spring, New York.
Lemon Springs, North Carolina.
Seven Springs, North Carolina.
Adams County Mineral Springs, Ohio.
Magnetic and Saline Spring, Marysville, Ohio.
Sulphur Lick Spring, Ohio.
Sizerville Magnetic Mineral Spring, Pennsylvania.
Chick's Springs, South Carolina.
Estill Springs, Tennessee.
Idaho Springs, Tennessee.
Dalby Springs, Texas.
Capp's Mineral Water, Texas.
Hynson's Iron Mount Springs, Texas.
Montvale Springs, Texas.
Richards' Wells, Texas.
Roseborough Springs, Texas.
Slack's Wells, Texas.
Tioga Mineral Well, Texas.
Brunswick White Sulphur Springs, Vermont.
Hunter's Pulaski Alum Springs, Virginia.
Powhatan Lithia and Saline Spring, Virginia.
Rockingham Springs, Virginia.
Silver Sand Spring, Wisconsin.