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# MINERAL RESOURCES

OF THE

## UNITED STATES

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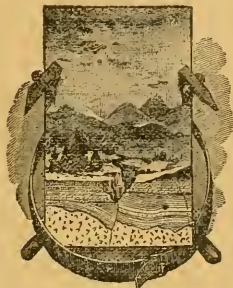
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DAVID T. DAY

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# PRECIOUS STONES.

BY GEORGE F. KUNZ.

This paper is founded on and is a résumé of the nine papers on the precious stones of the United States written since 1882 for the annual reports of the Division of Mining Statistics and Technology of the U. S. Geological Survey, on a report for the Eleventh United States Census, and the following is a condensation of these, together with additional information obtained from studying the collections in the United States and from personal examination of many of the localities where gems are found, and some notes on the gems and precious stones shown at the World's Columbian Exposition. The reader should also consult "Gems and Precious Stones of North America."<sup>(a)</sup>

*Systematic mining for gems.*—Although nearly all the known varieties of precious stones are found in the United States, there has been very little systematic exploration for them until very recently, as the indications seldom justified the investment of much capital in such search. Whereas mining for precious stones was only carried on in two States in 1889, the following gems were mined in 1893: Tourmaline in Maine, emeralds in North Carolina, turquois in New Mexico, sapphires in Montana, and opal in Washington state, Idaho, and Oregon. Otherwise the gems are found accidentally in connection with other substances that are being mined. They are often gathered on the surface, as is the case with garnet and olivine in Arizona and New Mexico; or in sluicing for gold, as with the sapphires from Montana; or in connection with mica mining, as the beryl from Connecticut and North Carolina; or from the beds of streams and decomposing rocks, as the moss agate from Wyoming; or on the beaches, as the agate, chlorastrolite, and thomsonite from the shores of Lake Superior.

Nearly all of the gems found in these various ways are sent to the large cities in small parcels or are sold in the neighborhood to tourists, or sent to other places to be disposed of as having been found where they are sold.

## DIAMONDS.

The occurrence of diamonds in the United States is chiefly confined to two regions, geographically quite remote. The first is a belt of country lying along the eastern base of the southern Alleghenies, from Virginia to Georgia, while the other extends along the western base of the Sierra Nevada and Cascade ranges in northern California and

southern Oregon. More recently (1891) they have been found in Wisconsin. In all three regions alike, the diamonds are found in loose deposits of gravel and earth, associated with garnets, zircons, iron sands, monazite, anatase, and particularly with gold, in the search for which they have usually been discovered. These loose deposits are merely the débris of the crystalline rocks of the adjacent mountains, and therefore present a general similarity, although the ages of the rocks themselves are widely different. The rocks of the Blue Ridge and eastern Alleghenies are of ancient Archean and Cambrian ages, while in the western belt the Sierra Nevada rocks were not elevated and metamorphosed until the middle or later Mesozoic. From this general resemblance of conditions the details of discovery in the two regions are very similar, and in both occasional diamond crystals are found, accidentally picked up on the surface, or more frequently encountered in the search for gold, sometimes in placer mining and sometimes in the flumes and sluices of hydraulic workings.

There have been various reports of the finding of diamonds in other parts of the country, but little or no positive evidence. A supposed diamond field in central Kentucky has been the subject of much study and discussion on account of the resemblance of the rock to that of the diamond-bearing region of South Africa; but upon closer examination important differences are recognized, and the diamonds are yet to be discovered. The formations in the eastern portions of the United States where diamonds have really been found are entirely different from those of South Africa, and are more like those of the diamond fields of Brazil and of parts of India. The diamonds found in the United States are evidently from much older rocks than those of South Africa, and if they have ever occurred in rock similar to that in Kimberly there is nothing to indicate it now, since the rocks in American diamond-bearing localities are mainly granitic.

North Carolina, so rich and varied in mineral resources, has long been known to yield some gold; and a few diamonds have been found in the same region, either loose in the soil or taken from the washings of auriferous gravel. The portion of the State is that known as the Piedmont region, a belt of country lying, as its name indicates, at the foot of the mountains, along the eastern base of the Blue Ridge. The rocks here are metamorphic and crystalline, with some Cambrian beds a little farther west.

Quite a number of small diamonds have been obtained since 1860 from the various points in this region, and they probably occur sparingly distributed throughout the auriferous belt of the Carolinas and northern Georgia. In the rude and hurried methods of gold-washing employed, they may often have been overlooked in the past, and now lie buried in the piles of sand that stretch for miles along the water courses.

On passing into Georgia the same metamorphic belt, with its localities for gold, itacolomite, and to some extent diamonds, extends across

the State to the Alabama line. In several of the counties lying along this belt diamonds are said to have been found; and it is quite possible that, as in North Carolina, they may occur occasionally in the entire line of country adjacent to the crystalline rocks.

Many notices have from time to time appeared, both in local newspapers and in scientific journals, of the occurrence of diamonds in California. They seem in all cases to have been imbedded in the auriferous gravels and thence washed out in the search for gold. These gold-bearing gravels are of two classes: first, loose material in the valleys and bars of modern streams, and, second, great accumulations, now covered with masses of lava and compact tufa, which occupy the valleys of more ancient streams, trenching the sides of the Sierra Nevada and running down into the valley of California, which lies between the Sierras on the east and the Coast Range on the west. Between these lava streams, which run out as spurs from the Sierras and from the divides between the modern streams, the latter have formed their own gravel deposits, partly from the wear of the old accumulations and partly from that of the mountain sides, as at first. The surface diggings and placers of the early prospective days of California were of course in these modern gravels and bars. The older gravels, equally rich, are worked either by the hydraulic process, or when compacted into what are called "cement beds," by stamp mills. It is in these deposits that the diamonds have been found, picked from the sluices and flumes. In the case of the cement beds, only fragments are obtained, as the diamond crystals have been crushed under the stamps. There is much in the mode of their occurrence that recalls at first sight the diamond mines of Brazil and South Africa. In Brazil the matrix is also a gravel, and is frequently cemented into a conglomerate "cascalho" by oxide of iron. The first recognition of diamonds in the State goes back to the early gold-seeking days of 1850, when Mr. Lyman, a clergyman from New England, was shown a crystal about the size of a small pea, with convex faces, and of a straw-colored tint. He saw it for a moment only, yet its general aspect was enough to identify it as a true diamond, and the interesting fact was published.<sup>(a)</sup>

The first diamond from the Cherokee district, Butte county, was obtained in 1853. This has since proved one of the principal localities in the State. In 1854 Melville Attwood called attention, in a newspaper article, to the similarity of the California deposits to the diamantiferous gravel and conglomerate of Brazil, with which he had become familiar by a residence there. He advised that search be made and care exercised, lest diamonds should pass unheeded in the gold washings. Since then diamonds have been reported from a number of points, and at present, according to Mr. Henry S. Hanks, formerly state mineralogist,

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<sup>a</sup> Am. Jour. Sci., II, Vol. 8, p. 294, Sept., 1849.

five counties, Amador, Butte, El Dorado, Nevada, and Trinity are known to have yielded them. Other localities and larger numbers are yet, in his judgment, to be discovered.

A few small diamonds have been found in the placer diggings of Idaho, of about the same quality, and occurring under the same conditions as those in California. Some excitement has occasionally arisen about these Idaho diamonds. In 1864 to 1866 local and mining papers made many references to reported or anticipated discoveries; but nothing of any importance was found. In the winter of 1892-1893 the matter has again attracted some attention, only small quartz crystals and no diamonds were found, the name Diamond Basin having given color to the reported findings. Diamond Basin lies on the Snake river in Owhyhee county, Idaho. The excitement, intense for a time, subsided before the winter was over.

A few years ago reports were started of the finding of diamonds in central Kentucky. Prof. Edward Orton, the State Geologist of Ohio, visited the district and observed certain resemblances to the diamond-bearing region of South Africa. He found dykes of eruptive rock (peridotite) breaking through fissures in shale, and spreading to some extent over the adjacent country. Garnets and other associated minerals derived from the decomposition of the peridotite were found, suggesting the possibility of a diamond yield from the similarity of the conditions to those of Africa. And the diamonds found at Dlaschkowitz, Bohemia, the writer attributes to similar conditions of occurrence.<sup>(a)</sup>

Similar investigations and results were reported by Prof. A. R. Crandall.<sup>(b)</sup>

It had been previously suggested by Messrs. E. J. Dunn, E. Cohen, H. Huddleston, and Rupert Jones, that the South African diamonds were formed in a sort of volcanic mud (Mr. Huddleston), by a process rather hydrothermal than igneous, resulting from the action of steam in contact with magnesian mud, under pressure upon carbonaceous shales.

In the chemical laboratory of the U. S. Geological Survey, Prof. J. Edward Whitfield found 37.52 per cent. of carbon in the shale from near the Kimberly mine, while in the blackest shale adjoining the peridotite of Kentucky he found only 0.68 per cent. of carbon. The peridotite at the time of its intrusion must have been forced up through a number of coal beds and at a greater depth it penetrated the Devonian black shale, which is considerably richer in carbon than the shale now exposed at the surface.

A small diamond field has lately been found in Pierce County, Wisconsin. Here gold occurs in the gravel and sand along Plum Creek and its smaller tributaries; and some sluicing has been done by private parties. During 1887 and 1888 several small diamonds were found in the

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<sup>a</sup> Trans. Am. Inst. Min. Engineers, 1892, p. 241.

<sup>b</sup> Note on the peridotite of Elliott county, Kentucky. Am. Jour. Sci., III Vol. 32, p. 121, Aug., 1886.

auriferous sands a little below the level of the stream; the largest is a rounded hexoctahedron of about three-fourths of a carat and could be cut into a brilliant of about three-sixteenths of a carat. The others are quite small.

#### SAPPHIRE.

Corundum is found in the United States chiefly in the crystalline rock along the Appalachian mountains from Chester, Massachusetts, to northern Georgia, Colorado, and Montana. At Chester, where the deposits have long been worked, the mineral exists mainly as emery; no gems have ever been found. In the metamorphic rocks of the Highlands of New York and northern New Jersey corundum is somewhat abundant. At Vernon, New Jersey, from 1850 on, crystals of sapphire and ruby corundum have been found, but always opaque; so that among many specimens obtained, some of which have been cut, scarcely any has furnished a transparent gem. It is of interest to note that near Mandalay, in Burmah, rubies occur similarly associated with limestone; hence they are generally found detached and separated from their original matrix.

Mr. C. W. Jenks, in 1870, commenced mining at Corundum Hill, Franklin, North Carolina, and obtained about one hundred gems; but although found here in their original matrix, they were so infrequent that it was found unprofitable to mine for them alone. Several sapphires, true blue and violet blue, weighing over one carat each, were discovered, as well as several fine rubies. The work was discontinued for some years owing to the financial crisis of 1873, but has lately been resumed by the Hampden Emery Company, which now own the mines. It is not easy to learn what success they have had, but certainly few or no gems have appeared in the market of late from that locality. Some very interesting specimens from here are shown in the North Carolina exhibit of the World's Columbian Exposition, Mines and Mining building, and a very remarkable 90-pound mass of red and blue banded sapphire from the lands of the Sapphire Valley Company, near Franklin, North Carolina, in the Tiffany gem collection in the northwest gallery of the Mines and Mining building.

The largest crystal of corundum ever found, five times larger than any other known crystal, is one early discovered by Mr. Jenks and described by Prof. C. U. Shepard. It is now in the cabinet of Amherst College, but it was injured by the disastrous fire of 1882, which destroyed many fine specimens of the Shepard collection. In variety of color the North Carolina corundum excels. It was found gray, green, rose, ruby-red, emerald-green, sapphire-blue, dark-blue, violet, brown, yellow, and of all intervening shades, and colorless. Many specimens have been cut and mounted, especially of the blue and red shades, and make good gems, though not of the choicest quality. Several fair rubies of 1 carat each have been found; a blue sapphire, 1 carat in weight, is in the United States National Museum at Washington, and a series of fine red and blue crystals have been deposited there by Dr. S. F.

Lucas, and a series from a recent find in the Tiffany exhibit, northwest gallery, Mines and Mining building, World's Columbian Exposition.

In Montana, sapphires are found at what are known as Eldorado Bar, Emerald Bar, French Bar, Ruby Bar, and for some 6 miles along the Missouri River; also in Missoula county, 70 miles distant. Stubb's Ferry, 12 miles east of Helena, is about the central point of the Missouri river district. Although these bars had been sluiced for gold, no systematic attempt had been made before 1891 to work them for gems. Occasionally sapphires were sent to the large cities, but owing to the cost of cutting them, and the small demand for any other than the true ruby-red or sapphire-blue stones, they received but little recognition.

The greater part of the region above described passed in 1891 into the hands of an English company bearing the name of the Ruby and Sapphire Mining Company, which has since obtained a large number of stones, some of which have been cut and exhibited in London. They embrace a great variety of the lighter shades—red, yellow, blue, and green. The latter color is quite pronounced and rather a blue green than an emerald green. Nearly all the stones, when finely cut, have a certain metallic luster strikingly beautiful and peculiar to the sapphires from this locality. No true red rubies or true blue sapphires have been found. A fine series of these gems was shown by Mr. Spratt in the Montana exhibit of the Mines and Mining building, World's Columbian Exposition, and mounted in jewelry by an American jeweler in the Manufacturers' building.

At all these bars along the upper Missouri the sapphires occur chiefly in a layer of auriferous glacial gravel, a few inches thick, which lies immediately in a slaty bed rock. Associated in the same layer were topaz in small crystals, garnets of a rich, ruby-red color, often mistaken for and called rubies, cyanite in broken crystals, cassiterite (stream tin), and other commoner minerals. The original source of the sapphires found at these bars is indicated in an eruptive dike, found cutting the slaty rock at Ruby Bar, on which rests the glacial gravel. In this eruptive rock there were found crystals of sapphire, pyrope, garnet, and sanidine feldspar. There seems no doubt that all the sapphire along these bars of the Missouri is derived from the breaking down, by glacial action, of a rock similar to this. The outcrop at Ruby Bar can not, however, account for the deposit of sapphires at Eldorado Bar, 6 miles to the north; and it will be necessary to await further discoveries before attempting to determine the exact source of these gems.

Mr. H. Miers finds the rock at Ruby Bar to be a vesicular mica-augite-andesite, containing an abundance of brown mica and porphyritic crystals of augite. The ground mass consists chiefly of feldspar micro-lites with a considerable amount of glassy, interstitial matter and much magnetite. Many of the cavities are occupied by a brown glass which appears yellow in thin sections and displays a speculitic structure originating in the sides of the cavities.

It is of course difficult to say whether or not the sapphires could have been caught up by the augite-andesite from schists or other rocks cut through in coming up, as may be seen in the case of the occurrences in the Eifel Laacher See at Unkel, and in Auvergne (Espailly), France.

During 1892 excavating and mining have been actively pushed on the property of the Ruby and Sapphire Mining Company, under the superintendence of the well-known mining engineer, Mr. E. G. Wood, who, it is said, lays considerable stress on the placer gold that he hopes to find in connection with the sapphires. During 1892 none or few gems from this property have been placed on the American market, although they have been publicly shown in England, and several minor gems have been cut and their product placed on the New York market. Up to this time it is impossible to state whether the gem market of the world will accept these "fancy-colored" stones in quantity when the demand in the past has only been for the standard ruby and sapphire. A number of minor deposits have been found and considerable interest has been shown in the property adjoining that of the larger company. Various lots of gems have been sent to New York, but the sale for the year, including those sold by the Helena (Montana) jewelers, does not exceed perhaps \$5,000, the sales generally being to tourists who are passing through or visiting Montana.

In October, 1892, the Montana Gold and Gem Mining Company was incorporated by some of the best known men in Helena. The property owned by the new company, comprising about 2,000 acres, is situated partly on Emerald Bar, about 15 miles from Helena, and partly at the mouth of Prickly Pear creek, covering 2 miles on both sides of the creek. The company proposes to mine for gold as well as for gems.

During the past year sapphires have also been found in Missoula county, 30 miles west of Phillipsburg, on the west fork of Rock creek, and 70 miles from the Missouri River locality. The sapphires obtained here are of yellow, blue, green, and other colors, associated with garnets, pyropes, etc., occurring in a gravel bed which is 4 feet in depth down to the bed rock, and is overlaid by 3 feet of loam. The sapphires are all found in this bed, and appear to be exceedingly plentiful, from ten to twenty being found in every pan of the gravel. The colors are steely blue, green, yellow, and a few pink or reddish stones.

#### SPINEL.

Spinel fine enough to be cut into gems has but rarely been found in the United States. A few specimens of a smoky blue or velvety green, and of a dark-tinted claret color, weighing about 2 carats each, have been found near Hamburg, Sussex county, New Jersey. Some half dozen from San Luis Obispo, California, of very good quality and of nearly 2 carats each, were brought to the notice of the writer by Mr. James W. Beath, of Philadelphia, Pennsylvania. A locality believed to lie between Monroe and Southfield, in Orange county, New York, was known to only two collectors, both now deceased. They secretly



worked the place on moonlight nights from 1862 to 1866, and extracted the monster crystals of black spinel peculiar to Orange county. From the sale of these specimens they realized over \$6,000, although many fine crystals were ruined in blasting and breaking out. Since the death of these workers the location has been lost.

#### TURQUOISE.

This mineral is found near Los Cerrillos, Santa Fé county, and in the Burro Mountains, Grant county, New Mexico; in the Turquoise mountains, Cochise county, and in Mineral Park, Mohave county, Arizona; near Columbus, Nevada; in Saguache county, Colorado, and Taylor's Ranch, Fresno county, California. The first-named locality is part of a group of conical mountains situated about 22 miles southeast of Santa Fé, New Mexico, and north of the Placer or Gold mountains, from which they are separated by the valley of the Galisteo river. They are composed of yellow and gray quartzite sandstones with porphyritic dykes.

During the past two years turquoise has been actively mined for by two companies, the American Turquoise Company and the Azure Turquoise Company; a few minor attempts by others have been made. The first of the two above-named companies, engaged in mining 6 miles from Los Cerrillos, New Mexico, reopening some of the mines originally worked by the Indians, and have found turquoise equal in color to the finest Persian material. Its stability in retaining color is equally great, not changing within a short time, as does the Egyptian turquoise, which was so extensively placed on the market about the time when the Persian mines were ceasing to yield. In 1891 the writer had started on a trip to Persia, intending to visit the famous mines of turquoise, when the first specimens from this district were sent to him at Berlin with a fixed price on each gem. Word also reached him of the scarcity of the true turquoise in Persia, and he subsequently had opportunity at Nijni Novgorod, of seeing nearly all the yield of the year. He returned to the United States, giving up the projected trip, and purchasing only the finest gems, as nearly all the material shown, although held at high prices, was not up to the standard of the American turquoise. Stones have been found at these new localities weighing up to 60 carats each, one of which was sold for about \$4,000; and it is now possible for the first time in the past half century to match a perfect turquoise necklace.

The Azure turquoise mines are in Grant county, New Mexico. The material is of rather a robin's-egg blue; that is, with a faint greenish tinge. This may be due either to a partial change or metamorphism which has taken place while the turquoise was in the rock, or it may be a local peculiarity. The stones are not the sky-blue of the more northern locality, but it is claimed by the owners of the mine that they are not subject to change of color. Turquoise has always been known as an unstable gem. Even the finest Persian stones are liable to change occa-

sionally with scarcely any warning, the alteration probably being due to the turquoise coming in contact with acid exhalations from the skin or with fatty acids or alkalies in soap, although wearers of turquoise are especially warned to remove the rings while washing their hands. Recent observations also indicate that turquoise is liable to injury from perfumes. The sale of turquoise during the year 1891 from these two localities has probably exceeded \$100,000, and, for 1892, \$175,000, and a greater amount for 1893 is expected, as quantities of this gem from an American market have been sold abroad for the first time. This gem has given the most substantial evidence of gem mining in the United States.

#### TOPAZ.

The gem topaz has been found in Huntington and Middletown, Connecticut; Stoneham, Maine; North Chatham, New Hampshire; Deseret, Utah; at Nathrop, Chalk mountain, Crystal Park, Florissant, and Devil's Head mountain, Colorado, and at Ruby mountain, Nevada, and crystals have recently been seen by the author from Palestine, Texas. The first discovery of topaz in the United States was at Trumbull, Connecticut, where it was found in a vein associated with chlorophane. Probably the most brilliant and beautiful crystals of North American topaz are those from Thomas mountain, Deseret, Utah, an isolated and arid elevation about 6 miles long. These crystals are larger than those from Nathrop, California, always white, evidently have been decolorized by heat or exposure to sunlight, and equally as brilliant as those from San Luis Potosi, Mexico, which they closely resemble, and exist in quantity great enough to suggest their use as an abrasive.

Many fine large topaz crystals have been found at Crystal Park, near Pike's Peak, El Paso county, Colorado. The crystals from this locality, remarkable for their color and clearness, have been fully described by Messrs. Whitman Cross and William F. Hillebrand under the title of "Minerals from the neighborhood of Pike's Peak, Colorado." (*a*)

At Devil's Head mountain, in the Colorado range, some 30 miles north of Pike's Peak, the topaz is found in isolated and usually loose crystals surrounded by distorted smoky quartz. The principal color is cherry, although wine-yellow, milky-blue, and colorless crystals were found. (*b*)

Since the discovery of these Colorado localities it is estimated fully \$6,000 worth of topaz have been sold as crystals and gems, notably a crystal weighing 18½ ounces (587 grams), found at Cheyenne, Colorado, during 1886, and two sherry-colored gems weighing 125 and 193 carats. During 1882 crystals from Herndon Hall, in the vicinity of Stoneham, Maine, were determined by the writer to be topaz, and further search resulted in the finding of a quantity of crystals.

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*a* Am. Jour. Sci., III, Vol. 24, p. 282.

*b* Contributions to the Mineralogy of the Rocky Mountains, p. 70 et seq.; Bulletin No. 20 of the United States Geological Survey, Washington, 1885.

During 1888 nearly 100 crystals, associated with phenacite, were found on Bald mountain, New Hampshire, which is only a few miles from the Stoneham locality. They were colorless, light green or sherry colored on the outer sides, and colorless in the center. The largest one measured  $1\frac{1}{2}$  inches in height and the same in thickness. In habit these crystals closely resemble those from Cheyenne mountain, Colorado, and some of them are equal in quality, though not in size, to any found in Colorado.

#### TOURMALINE.

Tourmalines of gem value were first discovered by Elijah J. Hamlin, at Mount Mica, Paris, Maine, in 1826. He, with several members of his family, among them the person of Dr. A. C. Hamlin, have worked the original locality at Mount Mica, Paris, Oxford county, Maine, finding from time to time remarkable specimens of tourmaline, some single stones of which have been sold for \$1,000 apiece. The gem has been found in various shades of green, grass green, olive green, pink, red, blue, yellow, and white. For the past ten years this locality has been worked by the Mount Mica Gem Company.

Enough gems have been found in this locality to realize over \$50,000. The finest collection of crystals from this locality is the combined collection of the discoverer and Dr. A. C. Hamlin, and presented by James A. Garland, Esq., of New York city, to the Mineralogical Cabinet of Harvard University. The famous Hamlin tourmaline necklace was exhibited in the Tiffany Pavilion at the 1893 World's Fair.

Some of the fine gems in this locality were in the possession of the late Dr. Charles I. Sheppard, and a fine series of crystals from the Tenny collection are in the Peabody Museum, Yale University.

Tourmalines were discovered at Mount Apatite, Auburn, Maine, in 1893. Several thousand crystals have been found, their value aggregating about \$5,000. The work was carried on in a desultory manner, and all the tourmalines from this locality being retained in their original crystalline condition. Tourmaline of gem value have also been found at Hebron and other localities in Oxford county, Maine.

In July, 1893, on the summit of one of the San Jacinto mountains in Riverside county, California, tourmaline was discovered in float crystals, generally green or black. Some good green, rose, red, white, and blue were found. The green crystals, on being broken open, were found to contain red and white centers. One crystal 9 inches and another 6 inches long were found and a number of gems were obtained. Work is now being done on the vein.

#### BERYL (EMERALD, AQUAMARINE).

The emerald variety of beryl is found in Alexander county, North Carolina. Emeralds and beryls suggesting them have been found at five different points, with quartz, rutile (the latter some of the finest ever found), dolomite, muscovite, garnet, apatite, pyrite, etc., all in

fine crystals. One of these localities, Stony Point, is about 35 miles southeast of the Blue Ridge and 16 miles northeast of Statesville, North Carolina. The country has a rolling surface, and lies about 1,000 feet above the sea. The soil, which is not rich, is generally a red, gravelly clay, resulting from the decomposition of the gneissoid rock, and hence under these circumstances it is easy to find the sources of minerals discovered on the surface. The unaltered rock was found at Stony Point at a depth of 26 feet and is unusually hard, especially the walls of the gem-bearing pockets. The Emerald and Hiddenite Mining Company was organized in 1881 to work the property at Stony Point, and has done so irregularly for periods varying from one week to eight months of each year. The entire output (including specimens of other minerals and other gems) since the organization of the company in 1881 to the present time amounts to about \$15,000. Some crystals have been found here measuring 8 inches in length and weighing 10 ounces, but no gem obtained has been sold for over \$100. At Stoneham, Maine, many transparent crystals of beryl have been found, and at least \$3,000 worth of gems have been sold from this locality; one gem weighed  $133\frac{3}{4}$  carats. At Mount Antero, Colorado, at an altitude of 14,000 feet, many beautiful crystals of beryl were found resembling in color and habit the crystals from Mourne mountain, Ireland; one crystal measured 4 inches in length, many of these afforded small gems, and fully \$5,000 worth were cut into gems.

A dark-green beryl, weighing 25.4 ounces, part of which would furnish gems of some size, was found in January, 1888, near Russell Gap road, Alexander county, North Carolina, and fine gems from this crystal were shown in the North Carolina exhibit and in the gem collection in the northwest gallery of the Mines and Mining building, World's Columbian Exposition. Deep golden brown and golden yellow crystals have been discovered in Mitchell county. Yellow and green beryl gems have been found in Alabama, near Coosa, Rockford county. The largest known beryl crystals have been obtained at Alger's Hill, near Grafton, New Hampshire, weighing 2,900 pounds and measuring 4 by 2 by  $2\frac{1}{2}$  feet. They were valueless as gems. White and pale gems have been found at Grafton and South Ackworth, New Hampshire, Mount Mica and Hebron, Maine. Very fine golden yellow beryls have been found at the Avondale quarries, Delaware county, Pennsylvania; one weighed  $35\frac{1}{16}$  carats and another 20 carats. Six fine yellow beryls were found at Manhattanville, New York city. At a mica mine between Litchfield and New Milford, Connecticut, many beryls, deep yellow, light yellow, yellow green, light green, and white have been found during the past seven years, which were cut into gems and extensively sold, the former under the name of golden beryl. About \$17,000 worth of beryls from this locality were sold within four years by the owner of the mine, S. L. Wilson.

## PHENACITE.

Phenacite was first identified in the United States in 1888 in the Pike's Peak range, El Paso county, Colorado, in fine crystals. Since then it has also been found on Mount Antero, where the crystals occur at an altitude of about 14,000 feet in a region of almost perpetual snow, accessible for only a short period in the summer. Some crystals of phenacite were described by the author as occurring on Bald mountain, North Chatham, New Hampshire, near the State line between Maine and New Hampshire, and also in the neighborhood of Stoneham, Maine. From all the localities gems have been cut from the transparent crystals.

## GARNET.

The pyrope (precious) garnets are found in the United States, in New Mexico, Arizona, southern Colorado, and Utah, where they are often mis-called rubies. In New Mexico they occur, it is believed, only on the Navajo reservation, where the Indians collect them largely from ant hills and scorpion holes, and are also said to pound them out of rocks. They are associated with olivine and chrome pyroxene. In north-eastern Arizona they occur in loose sand, and have probably been brought by the action of water from a point 50 miles to the north, where they occur, as the writer believes, in a peridotite rock. In western Arizona (on the same parallel with Fort Defiance), on both sides of the Colorado river, garnets are similarly associated with grains of peridot, a chrome pyroxene and a hyaline chalcedony. Here also they are found on the ant hills and near the excavations made by scorpions, and are collected by soldiers and Indians, and sold to the Indian traders who send them to the large cities in lots of an ounce and upwards. They vary from an eighth to a quarter of an inch in diameter and a few measure one-half inch across. They have never been found in place by any geologist, and it has been suggested that they are derived from some lower cretaceous sandstone, but it is very evident, from the associated minerals, that they have weathered out of a peridotite rock under an identical mode of occurrence as the pyrope garnets in Bohemia, Elliot county, Kentucky, and Kimberly, South Africa.

Although the garnets found in washing and mining for diamonds in south Africa (the so-called "Cape Rubies") are larger than those of Arizona and New Mexico, and perhaps equal to them in color by daylight, the latter are much superior by artificial light. Only the clear blood-red hue is then visible, while in the "cape rubies" the dark color remains unchanged. They are much used as gems, the annual sales amounting to about \$5,000 worth of cut stones. A few remarkably fine ones have brought from \$50 to over \$100 each, though others equally good have been sold for much less. Fine stones of 1 carat bring from \$1 to \$3 each, and exceptional ones even \$5. They seldom exceed 3 carats. Pyrope garnet of good color that has furnished gems has been found in the sands of some of the gold washings of North

Carolina. The peridotite rock of Elliott county, Kentucky, contains quantities of deep ruby-red grains of pyrope, locally regarded as rubies, having a specific gravity of 3.673 and varying from one-tenth to one-quarter inch in diameter. They are sometimes as fine in color as the Bohemian garnets, which they closely resemble. The lower cost of cutting stones abroad and the smaller size of the Kentucky garnets somewhat precludes the possibility of making them profitable to search for, although it might be possible to encourage the cutting by farmers in their leisure time, on the house industry system of the "Jura," Bohemia, and other European gem-cutting centers.

Large crystals of almandite garnet, some weighing 20 pounds, not fine enough for gems, but which might be cut into dishes or cups, measuring from 3 to 6 inches across, have been found near Morgantown and Warlick's Mills, in Burke county, North Carolina, and in Rabun county, Georgia. Many of them are transparent in part, varying in color from the purple almandine to pyrope red. Tons of these have been crushed to make "emery," and the sandpaper called garnet paper. The peculiar play of color observed in the North Carolina garnets is often due to inclusions. In those of Rabun county, Georgia, sometimes nearly one-quarter of the entire specimen is taken up by fluid cavities and acicular crystals of rutile. Quantities of fine purple almandine garnets are found in the gravel of the placer mines near Lewiston, Idaho, and near Helena, Montana, in rolled and pitted grains, from one-sixteenth to 1 inch across, and would cut into good gems or jewels for watches. Hoffman mentions good small crystals from Black canyon, Colorado river, Nevada. Fine small almandines are also found in the trachyte of White Pine county, Nevada. Tons of almandite garnet, generally opaque, are found in the gold washings near Helena, Montana, suggesting use as an abrasive, as is the garnet found and mined in large quantities in Lewis county, New York.

The Alaska garnets, so well known for their remarkably perfect crystals, which contrast beautifully with their dark gray matrix, occur in quantities near the mouth of the Stikkeen river, in the vicinity of Fort Wrangel, Alaska. They are found in a bed of mica schist, and when quarried out are carried about a mile to the river, and thence by boat to Fort Wrangel. Over \$1,000 worth are annually sold as specimens.

Spessartite (manganese alumina garnet) is the most interesting garnet yet found in this country, and never found as a gem anywhere else. It was found in Amelia county, Virginia, a few years ago in the working of the Allen mica mines. A cut stone weighing 96 carats is in the Tiffany-Morgan collection in the American Museum of Natural History, New York. Fine examples are shown in the Mines and Mining building and in the Manufactures building, and a remarkable one in the Smithsonian Institution collection, U. S. Government building, of the World's Columbian Exposition. Fully \$5,000 worth of this gem

were found, and as the mica mines have since been closed as unprofitable, this gem will undoubtedly become very rare.

Essonite, cinnamon garnet, cinnamon stone, or the hyacinth of the jeweler, has been found of good quality in Oxford county, Maine. Very fine essonites, red and yellow, were formerly found at Phippsburg, Maine, and at Warren, New Hampshire. Beautiful essonite crystals one-fourth of an inch in diameter, entirely transparent and quite flat, have been found between plates of mica at Avondale quarry, Pennsylvania, and near Bakersville, North Carolina. Some of these would cut into fine gems over a carat in weight.

*Hiddenite, lithia emerald, spodumene, etc.*—In 1881 Mr. J. A. D. Stephenson called the attention of Mr. William E. Hidden to a transparent spodumene and to the locality in which it was found. Mr. Hidden, supposing the mineral to be diopside, sent the specimens for examination to Dr. J. Lawrence Smith, who on investigation found it not to be diopside, but a transparent variety of spodumene, and named it after Mr. Hidden, who sent him the crystals. The crystals were first found loose in the soil with emeralds, but systematic mining revealed them in attached veins of the walls of the rock. The spodumene is generally more or less altered, hence its pitted or eaten-out appearance; but when found in the rock the crystals are quite perfect and unchanged. The crystals are always transparent, and range from colorless (rare) through light yellow and yellowish green into deep yellow emerald green. Some times an entire crystal has a uniform color, but generally one end is yellow and the other green. Its hardness is 6.5 on the prism faces. At first considerable difficulty was found in cutting it, owing to its remarkably perfect prismatic cleavage, which is very lustrous. Gems have, however, been cut up to  $2\frac{1}{2}$  carats in weight. Its specific gravity varies from 3.18 to 3.194.

The yellow color exhibited by the mineral in even the darkest green gems will prevent its competing with the true emerald. The Siberian demantoids or Uralian emeralds, as the green garnets are variously termed (erroneously olivine), resemble the hiddenite somewhat, but are generally darker, and in addition to their brilliancy have a play of fire or color that has made them highly popular, especially in the very small sizes, the small green garnets selling for a greater price than emeralds of the same size. When lithia emeralds were first introduced they had a considerable sale because of their novelty as a strictly American stone and from the newspaper notoriety which they gained through the controversy as to the true discoverer. Hence for a time the demand exceeded the supply, which, from the desultory working of the mine, was limited. Thus a  $2\frac{1}{2}$  carat stone was sold for \$500, and a number of stones brought from \$40 to over \$100 a carat. The total sale of all the gems found from the beginning of operations in August, 1880, to the close of 1892 amounted to about \$8,000.

Peridot (olivine chrysolite) is found in the form of small olive-green pitted grains in the sands of Arizona and New Mexico and at Ison's mills, Elliott county, Kentucky. In the two former localities they are called Job's tears (on account of their pitted appearance). These afford smaller gems than those from the Levant. As the demand seems to be for large peridots of the richer olive-green color, which is not possessed by those from the United States, \$5,000 would be an outside valuation for the American peridots cut into gems since 1880.

*Olivine in meteorites.*—There have been found in several instances in the United States—Eagle Station, Carroll county, Kentucky, and Kiowa county, Kansas—meteorites of the type known as pallasites, containing olivine in crystals or masses disseminated through the iron. Some of these olivine grains have been fine enough to furnish good peridot gems. The meteorite found in Kiowa county, Kansas, is a true pallasites with very sharply defined crystals of bright yellow olivine, which break out and leave their casts in the iron; the one from Carroll county, Kentucky, consists largely of olivine with the iron traversing it in irregular meshes and fillings. In the Turner and Liberty mounds in the Little Miami valley, Ohio, some pieces have been found both natural and hammered into articles of use or ornament of a similar pallasite iron, but apparently not identical with either of these other falls, and in the meteorite found in Glorietta mountain, Santa Fe county, New Mexico, olivine grains were found, and from all four of these meteorites the olivine has been cut into what might truly be called a celestial gem.

*Quartz (rock crystal)* has been found near Long Shoal creek, on a spur of Phoenix mountain, in Chestnut Hill township, North Carolina, also at two places 600 feet apart (about 1 mile from the former crystals), one weighing 285 pounds, that was 29 inches long, 18 inches wide, and 13 inches thick, showing one pyramidal termination entirely perfect and the other partly so; also another specimen that weighed 188 pounds, as well as many pieces weighing from 10 to 50 pounds each. A crystal ball over 5 inches in diameter, and a number of art objects made from the rock crystals found, were exhibited at the World's Columbian Exposition; these were all of American work. A rock crystal ball from the summit of Mount Antero, Colorado, was shown in the Mines and Mining building of the World's Columbian Exposition. It measured a trifle less than 6 inches in diameter. It is not perfect, but quite equal to the crystal balls of the eighteenth century.

At Lake George, in Herkimer county, and throughout the adjacent regions in New York, the calciferous sand rock contains single crystals and at times large cavities are found filled with doubly terminated crystals often remarkably perfect and brilliant. These are collected in numbers, and both natural and cut specimens are mounted in jewelry and sold to tourists under the name of "Lake George diamonds." A remarkably choice collection of fine quartz crystals was shown by Mr. A.



B. Crim, of Middleville, New York, in the west gallery of the Mines and Mining building, World's Columbian Exposition.

At Crystal mountain, Arkansas, and in the region around Hot Springs for about 40 miles, large veins of quartz are frequently met with in a red sandstone, the exact geological horizon of which has not yet been accurately defined. They are mined by the farmers, who bring them to Hot Springs in wagons and sell them to local dealers and tourists. At least \$10,000 worth are annually sold to be taken away as mementoes. Great quantities of imitation (paste) diamonds are sold to the unwary as cut rock crystals, and quantities of foreign crystals as Arkansas quartz of local cutting.

Many localities in Colorado, notably Mount Antero, yield fine specimens of quartz. All along the Atlantic coast, at Narragansett Pier, Long Branch, Atlantic City, Cape May, Old Point Comfort, and other places, transparent pebbles are found in the sand and are much sought after by visitors, who often have them cut as souvenirs. At many such places the local lapidaries have been known to substitute for pebbles found on the beach foreign-cut quartz, cairngorm, topaz, crocidolite, moonstone from Ceylon, and even glass, obtaining twice the value of the foreign gem for the price of the supposed lapidary work. Many thousands of dollars' worth of such stones are sold annually. At all of these resorts large quantities of the quartz pebbles are cut into gems and seals, and all manner of ornaments are sold as having coming from the vicinity. Sometimes even the stones found by the visitors and intrusted to lapidaries for cutting are exchanged for cut stones brought from Bohemia, Oldenburg and the Jura. Cutting is done abroad on so large a scale and by labor so poorly paid that the cut stones can be delivered in this country at one-tenth of the price of cutting here, as the rock crystal itself has but little value. In the West there are many dealers who sell so-called "Rocky Mountain Gems," the entire stock frequently not containing a genuine stone, all being glass imitations. The same is true of all the blue moonstones and various stones sold in great quantity at the World's Columbian Exposition.

Amethyst is found on Deer hill, at Stow, Maine, where there is a vein of amethystine quartz which has been traced fully one-quarter of a mile and has furnished thousands of crystals during the last twenty years. A few have been of some gem value. Among some found in 1885 was a remarkable mass that yielded a gem weighing 25 carats of the deep purple color of the Siberian amethyst. Fine amethysts have been obtained at Mount Crawford, Surry, Waterville, and Westmoreland, New Hampshire. At Burrillville and at Bristol, on Mount Hope bay, Rhode Island, fine amethysts were found and used as ornaments over sixty years ago. Crystals of fine quality, though not affording gem material, one weighing seven pounds, have been found in Upper Providence township, Delaware county, Pennsylvania. Fine crystals and gems have been found in western North Carolina, and in Rabun county, Georgia. The mode of occurrence of the above gem is identical with

those in the Taljan and other mines in the government of Perm, Ural mountains, Asiatic Russia, which mines have furnished the finest known gems for a century and a half where single stones have sold for \$500 each.

Perhaps the most unique gem in the U. S. National Museum at Washington is an amethyst found at Webster, North Carolina, and deposited by Dr. H. S. Lucas. It was originally of a turtle-shaped form, which has unfortunately been lost by chipping; and it is said when found to have borne marks of the handiwork of primitive man. It now measures  $3\frac{2}{5}$  inches in length,  $2\frac{3}{5}$  inches in width,  $1\frac{1}{2}$  inches in thickness and weighs  $4\frac{3}{4}$  ounces. Some very fair amethysts have been found on the Lake Superior shore and in trap rock at Keweenaw point and elsewhere in the upper peninsula of Michigan.

Smoky quartz, also known as smoky topaz, cairngorm, and citrine, is abundant at and near Pike's Peak, Colorado; also to some extent on the summit of Mount Antero, Colorado; Three-Mile Gulch, near Helena, Montana; Magnet Cove, Arkansas; Burke and Alexander counties, North Carolina, Oxford county, Maine, etc. At Pike's Peak it occurs in pockets in a coarse pegmatitic granite, often associated with beautiful crystals of amazon stone and flesh-colored and other feldspars. The largest Pike's Peak crystal found is over 4 feet in length. A beautiful faceted stone measuring 84 millimeters ( $3\frac{1}{3}$  inches) was shown by Messrs. Tiffany & Co. at the World's Columbian Exposition, found in 1891 on Mount Antero, Colorado. The Pike's Peak material is sent abroad in large quantities to be cut, and the larger part is returned to be sold in tourists' jewelry, principally at Denver and Colorado Springs, Colorado; Hot Springs, Arkansas, and in other Western cities and summer resorts. The sum realized from the cut material amounts to about \$7,500 annually, and that from the crystals sold to \$2,500 more. Most of the cut articles of smoky quartz sold at the tourists' resorts are either from foreign localities or are American material cut abroad. Smoky quartz pebbles are occasionally found along the Atlantic coast at Long Branch, Cape May, etc., and cut as souvenirs.

Rose quartz occurs in large masses at Albany and Paris, Maine, Southbury, Connecticut, and at many other places in the United States; but as yet it has not been used in the arts or as a gem. At Stow, Albany, Paris, and other localities in Maine the quartz veins shade from white-transparent and opalescent—resembling hyaline quartz often without any imperfections—through faintly tinted pink and salmon into a rich rose color, thus forming a beautiful series of tints for gems or for ornamental work. Specimens of this rose quartz, when cut into double cabochons or spherical objects, distinctly show the asteria effect, similar to the star sapphire. Possibly as fine transparent, opalescent, rose quartz as has ever been found was obtained at Round mountain, Albany, Maine, in pieces measuring 4 by 5 inches in size, free from all flaws and of a fine rose red, with a beautiful milky opalescence. A sphere  $2\frac{1}{2}$  inches in diameter and various art objects cut from this material are shown at the World's Columbian Exposition.

*Gold quartz.*—When clear, compact, white quartz contains veins, streaks, or spots of fine gold, it is worked into jewelry and souvenirs on a considerable scale in San Francisco. The mines in California, Oregon, Idaho, and Montana have furnished very fine specimens, especially when the quartz is clear and the gold penetrates in compact stringers. The gold found in California quartz is worth about \$16.50 an ounce, but jewelers willingly give \$20 to \$30 for each ounce of gold contained in material that they can thus use. The price of specimens is governed by their beauty, varying from \$3 to \$40 per ounce of quartz. The specific gravity of the mineral is first taken, after which the gold value of the quartz is ascertained by Price's table. The amount of this material sold in the rough for jewelers' purposes is variously estimated at from \$40,000 to \$50,000 a year, \$1,000 to \$2,000 worth being often purchased at one time. One lapidary at Oakland, California, where most of the cutting of this material is done, bought nearly \$10,000 worth within a year; and a large jewelry firm in San Francisco, during the same time, purchased nearly \$15,000 worth. A clever imitation of this was patented some years ago by a San Francisco lapidary, who put grains of gold from common gold quartz in a magma of molten white glass the color of a milky quartz.

*Novaculite* (whetstone or honestone) is a fine grained, compact, sandstone-like substance, found in large pieces at Hot Springs, Arkansas, and employed to a limited extent for cutting into figures such as birds for jewelry. It is extensively used for whetstones, which have a world-wide reputation as Washita whetstones. Its compactness and the purity of its white color make it a very pretty ornamental stone and it should be used for this purpose more than it has been.

*Sagenite.*—Rutilated quartz of unexcelled beauty (rutile in quartz, Flèche d'amour, or Venus' hairstone), the rutile usually brown, red, golden, and black, has been found in many places in Randolph, Catawba, Burke, Iredell, and Alexander counties, North Carolina. Fine pieces of quartz, 4 inches square, containing acicular rutile of a rich red color, have been found near Amelia Court House, Virginia. Cut specimens command prices ranging from 25 cents to \$5 each, and at one time about \$500 worth was sold annually. The specimens found here are quite equal to the variety found in Japan, and are even better adapted for use in jewelry than the remarkable transparent masses over a foot across, procured from Madagascar, in which the crystals of hornblende are too large. Quartz crystals with inclusions of goethite have been found in the Tarry-All mountains 40 miles west of Colorado Springs, and cut into beautiful ornaments resembling quartz penetrated by acicular rutile.

The most magnificent specimen known was found in boulders from the vicinity of Hanover, New Hampshire, during the years 1830 to 1850.

Thetis' hairstone, of Dr. Charles T. Jackson, is found near Sneatch Pond, Cumberland Hill, Rhode Island, is occasionally met with in fair

pieces and is used to a very limited extent in jewelry. It is transparent quartz so completely filled with acicular crystals of green actinolite as to make it quite opaque. Probably \$100 worth was at one time sold annually to be cut into seals and charms.

*Dumortierite in quartz.*—This is a rare species, a nearly pure silicate of alumina, very near staurolite in composition, but without the iron; it exists in small amounts at Harlem, New York, and has of late been found in some quantity at Clip, Yuma county, Arizona. Here it occurs as a dense fibrous inclusion in quartz, to which its deep blue color imparts the appearance of lapis-lazuli in masses one foot square. As the quartz and the dumortierite are about equal in hardness, the mass polishes well and yields a fine dark blue ornamental stone. A locality was discovered in Riverside county, California, in July, 1893.

*Agate.*—Agate is not produced in sufficient quantity in the United States to admit of exportation. The annual production and sale here does not exceed \$2,000. Nearly all the agate jewelry sold in this country, as elsewhere throughout the world, comes from Oberstein and Idar on the river Nahe in the Duchy of Oldenburg, where the manufacture of such articles has flourished for over three centuries.

Agate pebbles, in quantity small and of great beauty, are at Agate Bay, Lake Superior. These are sold to the tourists at all the Lake Superior cities.

Agate in bowlders from a few inches to a foot across, of rich red brown and mottled tints, is found in the vicinity of Austin Bluffs, near Colorado Springs and Colorado City, Colorado. In Colorado, chalcedony is found 8 miles south of Cheyenne mountain, at the Los Pinos Agency, at Chalk Hills on the bluffs near Wagon Wheel Gap, and along the upper Rio Grande valley, in Middle South Park, Buffalo Park, Fair Play, Frying Pan, along Trout creek and Gunnison river, and frequently in drift accumulations. In Pinal county, Arizona, large quantities of amygdules of beautifully banded agate are found, often coated with opal. They vary from 1 to 8 inches in diameter, and when broken are generally light bluish gray or light gray in color. They would be extremely beautiful if cut and polished. Seven miles south of Cisco, Utah, there are extensive beds of flesh red, pink, and salmon-colored agate, which received considerable press notice under the name of "blood-agate," and a company has been formed to work it.

The beautiful little agates found on Pescadero beach in California are sold in large quantities and in different forms, polished and unpolished, loose or in vials of water. Occasionally some of these are found inclosing a pebble moving in liquid, like the hydrolites from Uruguay and the chalcedony from Tampa bay, Florida. These pebbles, which may well be called sealed flasks, vary from one-tenth to one-fourth of an inch and rarely are one inch in diameter. They are also found on the Oregon coast near Yaquina bay and Astoria, where they average an inch or more in diameter. They are of quite frequent occurrence in pebbles little larger than a pea at Pescadero beach near San Francisco. An-

other locality is Canyon Springs in southern California, as reported by Mr. Orcutt. He also reports beautiful chalcedonies and agates in the drift of the Colorado desert and the neighboring mesas. Fine examples of chalcedony replacing coral and sponges are also found at Tampa bay, Florida, a few holding more than half a gill of water each. The chalcedony coatings on the blue and green chrysocolla occurring in the cavities of the Copper Queen mine, Arizona, are very beautiful if cut with their inclosures and form some of the prettiest and most interesting gem-stones ever found. Fully \$10,000 worth of this material has been sold in its natural state for cabinet specimens.

Chrysoptase is found in a vein of serpentine in the nickel mines at Nickel Mount near the town of Riddles, Douglas county, Oregon. It occurs there in veins over an inch thick in the nickel ore, and a few fine rich green stones several inches square have been obtained. Some were shown in the southwest gallery of the Mining building in the World's Columbian Exposition. Some fine stones were also found near Visalia, Tulare county, California, by Mr. M. Braverman.

Jasper Bloodstone or heliotrope in beautiful specimens with very fine red marking is found in Chatham county, Georgia. Heliotrope was formerly obtained in the veins in slate at Blooming Grove, Orange county, New York. Good specimens have been found near the Willamette river, Oregon, near the South Park, Colorado, and below the Uncompahgre near Grand river.

Silicified wood, also known as wood agate and wood opal, is found in great abundance in Colorado, California, Arizona, New Mexico, and other western States and Territories. The agatized wood found at Chalcedony Park and elsewhere in Arizona is one of the most beautiful high-class ornamental stones known. Magnificent collections of polished specimens, some nearly 3 feet in diameter, are shown in the Arizona and South Dakota exhibit and in the Manufactures Building of the World's Columbian Exposition.

On a visit to the locality for the Eleventh Census the writer found that Chalcedony Park, near Holbrook, Arizona, the nearest of the so-called forests in the formation on the Atlantic and Pacific railroad, is about a mile square and is inclosed by table lands from 50 to 100 feet high, composed of several beds of variously colored sandstone, red, white, black, etc. Nearly all the agatized trunks are found lying on the plain below, but they were never in place there. They have been weathered out in the decomposition of the upper layer of sandstone and have rolled down upon the plain. None of those remaining in the upper layer are found in the erect position, nor were any roots visible, and, since none of the trees retain any of the original bark, it seems probable that all this deposit was once the bed of an inland sea or lake. Another deposit, 3 miles from Los Cerrillos, New Mexico, very closely resembles that of Chalcedony Park, in Arizona. Two sections from this locality, weighing about a ton each, are in the Historical Society's collection at Santa Fé, New-Mexico.

Prof. A. A. Julien, in a communication to the New York Microscopical Society, in January, 1892, announced the discovery of the well-preserved mycelium of a fungus, secreting iron oxide in the jasperized wood from Arizona. To which he attributes the coloration of the agate as detailed in the last report of this series.

Agatized wood in large quantities, consisting of trees from 12 to 35 feet in length and from 18 inches to 2 feet in diameter, has been found near Calistoga, in Napa county, California. True examples of agatized and opalized wood and bluish chalcedony associated with quartz are found in the vicinity of Gallatin, Montana, great quantities of which were collected by Dr. Albert C. Peale and Prof. George P. Merrill, and later by Prof. Frank H. Knowlton, of the United States Geological Survey, for the United States National Museum.

#### OPAL.

Opal was not observed as a precious stone in the United States until 1889. Since then it has been found in gems equal to the Hungarian in Washington State, Idaho, and Oregon.

In August of 1890 a fine opal was detected in digging a well near Whelan, 20 miles southwest of Colfax, in Washington State. This was in latitude 47 degrees north and longitude 117 degrees west, about midway between the Cœur D'Alene and the Nez Perce Indian reservations, near Moscow, Idaho, almost on the line between Idaho and Washington. It occurred more or less plentifully, and 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 appears to be altered. Buildings have been erected and the locality named Gem City. The total yield of these mines, during the summer and fall of 1891, amounted to over \$5,000; the opal is fine, in many respects equal to the best material from the Hungarian or Australian mines. A gem weighing  $3\frac{1}{2}$  carats from this district was held at the extravagant figure of \$500, partly perhaps on account of its American origin, and a rough mass of 2 ounces at \$1,200. If the material is as abundant as supposed, and is properly worked, it is likely to be one of the most promising of our precious stones from a financial point of view, notwithstanding the abundance of fine stones now being found in Queensland and more recently at Wilcannia, New South Wales.

Some remarkable fine fire opals have been found 30 miles from Hepper, Morrow county, Oregon. At this place, immediately overlying a bed of hardened or baked clay or silicified slate, there is a deposit of eruptive ashes about 4 feet in thickness. This, in turn, is overlaid by red lava and other lavas to the top of the mountain. In this bed of ashes are found large nodules or spherical masses from 1 to 40 per cubic yard. These vary in size from one to several feet. On breaking them open, they are found to obtain some kind of opal, of which one in twenty is a fire opal or a noble opal. It is estimated that some \$20,000 worth of specimens have been obtained here during 1892; many of these were stolen at the Spokane fair so that the estimate may be exaggerated.

Quite a number of opals of good quality have been found in the Owyhee mountains at Opaline, 20 miles from Silver City, Owyhee county, Idaho, and about 30 miles from Boisé City. In the north-western part of that county there are extensive lava beds in which are layers of tufa; in this tufa and in the overlying stratum some very fine opals, weighing from 3 to 20 carats, have been found; they are generally associated with hydrophane and some have been sold for from \$5 to \$40 a carat. Opals have also been discovered in Latah county, Idaho, where they are mined by two companies, and near Moscow in the same State. A fine collection was shown in the Idaho exhibit, Mines and Mining building, World's Columbian Exposition.

A white opaque variety of hydrophane in rounded lumps from 5 to 25 millimeters (one-fifth to 1 inch) in diameter, with a white, chalky, or glazed coating, somewhat resembling the eacholong from Washington county, Georgia, has been found in Colorado. It is remarkable for its power of absorbing liquid. When water is allowed to drop slowly on it it first becomes very white and chalky and then, by degrees, perfectly transparent. This property is so striking that the finder has proposed for it the name "magic stone," and has suggested its use in rings, lockets, charms, etc., to conceal photographs, or other objects which the wearer wishes to reveal only at his pleasure.

#### MOONSTONE.

Moonstone, albite variety, has been found in fine large masses at the Allen mica mines, Amelia county, Virginia, and in Delaware county, Pennsylvania. Very few moonstones that are transparent have been found in the United States. During 1892 transparent moonstones in very beautiful small crystals (too small to be of value) were found in some quantity by Clement Hightower on the headwaters of the San Francisco river, a tributary of the Gila, 18 miles east of the Arizona line, New Mexico. No moonstones are found on our coast; those so reported are of Ceylonese origin and passed off as of American origin.

#### SUNSTONE.

Beautiful varieties of orthoclase sunstone are found near Crown Point and Chappaqua, New York. It also occurs at Amelia Court-House, Amelia county, Virginia. A very interesting variety of sunstone was found by Mr. J. A. D. Stephenson at a quarry in Statesville, North Carolina; the reflections are as fine as in that found at Twedde strand, Norway, but the spots of color are very small. Several hundred dollars worth from this locality have been sold as gems.

Labrador spar is found in large quantities in Lewis and Essex counties, New York, and as bowlders in the drift all the way down to Long Island and New Jersey. In Lewis county the bowlders are so plentiful in one of the streams that it has been named Opalescent river. Large quantities of this labradorite rock are quarried at Keesville, Essex

county, New York, for monumental and building work. It is polished there for similar purposes at a cost of about \$1 a square foot, and finds a ready sale under the name of Au Sable granite. It somewhat resembles the labradorite from Kief, Russia.

Amazonstone (microcline) is found at Pike's Peak, Colorado, in cavities, in a coarse pegmatite granite with smoky quartz crystals, often of huge size, and with flesh-colored and white feldspars. When associated with smoky quartz it makes a most pleasing and effective combination. Many thousand amazonstone crystals of the most beautiful green color have been obtained, measuring from one-half an inch to over 12 inches in length, and of different shades of green, from the lightest and most delicate to a deep apple green. The crystals are often in groups, the bases of which are covered with white albite. The groups in the New York State Museum at Albany, in the collections of Mr. Clarence S. Bement in Philadelphia, and of Mr. Frederick A. Canfield in Dover, New Jersey, are among the finest known. It is frequently cut into gems or ornamental stones, and large quantities are sold annually to tourists.

Several localities in North Carolina also furnish this mineral. Rockport, Massachusetts, formerly afforded richly colored pieces and some fine green crystals have been found at Paris, Maine; also at Mount Desert, Maine, material that would cut into fair gems is occasionally met with. Several light-green crystals over 6 inches long, and one over 10, were found in the Allen mica mines, Amelia Court-House, Virginia. From the Pike's Peak locality over \$10,000 worth have been sold as specimens at prices as high as \$200 for a single specimen. Over \$1,000 worth from this place is annually cut into tourists' jewelry. In Middletown, Delaware county, Pennsylvania, many shades of green feldspar passing into cassinite and delawarite are found in the soil in loose boulders up to 20 inches in diameter.

Obsidian in nodules is found in the lower members of the trachytic dike. There is a dike of light gray and clear obsidian with concentric structure near the Colorado Central lode, north of Saguache creek, near Georgetown, Colorado. Obsidian in fine pieces is very abundant 10 miles southeast of Silver Peak, Nevada, and at Obsidian Cliff, in the Yellowstone Park, Wyoming. This locality is described by Mr. Joseph P. Iddings, (a) who says: "The cliff presents the partial sections of a floor of obsidian, the dense glass constituting the lower portion, which is from 75 to 100 feet thick. One of its remarkable features is a primitive column forming its southern extremity, which rises 50 or 60 feet and is only 2 to 4 feet in diameter.

*Chondrolite* that could be cut into gems has been found at the Tilly Foster mine at Brewster's, New York. During 1891 and 1892 some fine transparent garnet-colored crystals were found measuring one-half by one-fourth inch and a few over 4 inches across, some of which would furnish fine gems.

a Seventh Annual Report of the United States Geological Survey, p. 254 *et seq.*



## JADE.

As regards origin, some early writers have attributed the Alaskan nephrite native implements to a Siberian source. Native reports pointed to a source known as the Jade mountains north of the Kowak river, about 150 miles above its mouth, and after several attempts the spot was visited in 1882 by Lieut. G. M. Stoney, U. S. Navy. He collected specimens of jade in situ and a number of samples were examined. A magnificent series of archaeological objects of Alaskan jade is in the United States National Museum. Lieut. Stoney found that the implements and jade in situ are identical, thus disposing of the theory that their presence in Alaska is to be accounted for upon the basis of trade with Siberia. That theory is also negated by the discovery announced by Prof. George M. Dawson, of small nephrite boulders on the upper part of the Lewis river, not far from the eastern boundary of Alaska. But these nephrites are also strikingly like those from many other localities. The most remarkable specimen of jade (nephrite) or pectolite found on this continent is the boulder (weight  $47\frac{1}{2}$  pounds) from southern Oregon, now in the James Terry collection of the American Museum of Natural History, New York, which museum during 1892 acquired the George F. Kunz collection of 449 specimens of jade and allied minerals, which with the Terry, the "Squier and Davis," the Lieut. Emmons, the Bement, and the objects formerly owned by the Museum, makes this the finest collection of archaeological jade known. No American jade has as yet been utilized in the arts. The compact pectolite found in Alaska and in Tehama county, California, is tough, and resembles some white Chinese jade and would make the best known substitute for it. The so-called jade from near Candelaria, Nevada, of which there was quite a mine, proved to be a green agalmatolite, a soft mineral of no little value as an ornamental stone but useful in the arts as a powder.

*Rhodonite*, so extensively found and cut in Russia, has been little utilized in this country. It has been found in an extensive bed at Blue Hill bay, Maine, and on Osgood's farm near Cummington, Massachusetts, in very fine large masses and in the neighboring towns, in Warwick, Massachusetts, in Irasburg and Coventry, Vermont, near Winchester and Hinsdale, New Hampshire, and at Cumberland Hill, Rhode Island.

## ZEOLITIC GEMS.

Among the Zeolitic gems may be mentioned Zonochlorite, referred to prehnite by Hawes. This gem was found at Neepigon bay, Lake Superior, by Dr. A. E. Foote, in 1877, and is generally of a dark-green color, its name being suggested by the bandings which are characteristic of it. A few thousand dollars would represent the commercial value of all the stones found.

Chlorastrolite is found on the beach at Isle Royal in more or less profusions, where they are weathered out from the Amygdaloid rock in which they are found. They vary in size from that of a pea to a few

exceptional stones measuring nearly 2 inches in length, generally selling from 25 cents to \$5 each by the jewelers of the Lake Superior region; \$25 to \$100 have been paid for a few of the remarkable stones. For the past twenty years from \$1,000 to \$5,000 worth of these stones have been annually sold to be cut into gems or to be taken away as souvenirs.

Thomsonite, generally flesh-colored and beautifully marked with white bands and with green layers (lintonite), is found in great profusion at Grand Marais, Minnesota. This stone is also weathered from Amygdaloid rock, and is generally in grains varying in size from the pea to more than an inch across. Ten dollars is an exceptional price for even the finer specimens; they can generally be bought for from a few cents to several dollars each. In the past ten years from \$500 to \$1,500 worth have been sold annually.

Fossil coral, generally (Favosites) compact with a grayish-cream color, is found in beautiful masses at Iowa City, Iowa, and in pebbles at the beach at Petosky, Michigan. At the latter place it is known as Petosky marble. The local jewelers in both places cut and polish this material into paper weights, charms, etc., and \$1,000 to \$2,000 worth are sold annually.

Rutile is found in beautiful, brilliant crystals in Alexander county, North Carolina. In this district the crystals are generally compact enough to admit of the cutting into brilliant stones, with a luster that they are almost indistinguishable from the cut black diamond.

Pyrite is more or less sold for ornamental purposes in two districts in the United States. First at Wilkesbarre and other parts of the Pluma coal district, where the thin crusts of brilliant crystals are cut into oval, square, and other forms for scarf pins and other ornaments. In this form several thousand dollars worth are sold annually. In Colorado single crystals or small groups of brilliant crystals in their natural position and to the value of several thousand dollars worth are sold annually. It is not cut into faceted forms as is the same mineral in France, which is known there as marcasite.

#### TITANITE (SPHENE).

A very remarkable discovery of titanite has been made at the celebrated Tilly Foster iron mine, at Brewster's, Putnam county, New York, where Mr. E. Schernikow obtained several hundred magnificent crystals from 1 to 2 inches in length. Nearly all have highly polished faces, and some are beautifully twinned. They are of fine yellow shades, many of them transparent, and a number are large enough to cut into gems of from 1 to 15 carats each. These were found in the summer of 1891, and are among the finest titanites that have been observed in any recent locality, equaling some of the best crystals from Tavetsch or other celebrated places of occurrence abroad. Over \$1,000 worth were sold as gems. Some of the finest crystals are shown in the southwest gallery of the Mines and Mining building at the World's Columbian Exposition by Mr. George L. English, and a fine cut gem of ten carats

is in the collection of the United States National Museum. Some fine gems have been obtained at Bridgewater station, Delaware county, Pennsylvania, and small crystals at Magnet Cove, Arkansas.

PRODUCTION.

The following table shows the value of the precious stones produced in the United States from 1885 to 1892, inclusive:

*Estimated production of precious stones in the United States from 1885 to 1892.*

Species.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.
	Value.	Value.	Value.	Value.	Value.	Value.	Value.	Value.
Diamond		\$60						
Sapphire gems	\$500	750	\$500	\$500	\$6,725	\$6,725	\$10,000	\$20,000
Chrysoberyl								
Topaz	1,250	1,000	2,000	600	400		100	1,000
Beryl	750	5,500	3,500	800				1,500
Phenacite				650	200			
Emerald	3,200	3,200		100	450		a1,000	
Hiddenite	2,500	4,500						
Tourmaline	600	5,500	500		2,250	2,250	3,000	3,000
Smoky quartz	7,000	7,000	4,500	4,000	4,222	2,225	5,000	5,000
Quartz	11,500	11,500	11,500	11,150	14,000	14,000	10,000	10,000
Silicified wood	6,500	1,500	36,000	16,000				1,000
Garnet	2,700	3,250	3,500	3,500	2,308	2,308	3,000	5,000
Anthracite	2,500	2,500	2,000	1,500				3,000
Pyrite	2,000	2,000	2,500	2,500	2,000	2,000	1,500	1,500
Amazonstone	2,750	2,250	1,700	1,700	500	500		1,000
Catlinite (pipestone)	10,000	10,000	5,000	5,000	5,000	5,000	5,000	5,000
Arrow points	2,500	2,500	1,500	1,500				1,000
Trilobites	1,000	1,000	500	500				
Sagenitic rutile	250	1,750						
Hornblende in quartz	300	200	100					
Thomsonite	750	400	750	500	400	400	200	500
Diopside	100		50					500
Agate	2,000	2,000	4,000	4,000				2,000
Chlorastrolite		1,000	800	800	500	400	500	500
Turquoise	3,500	3,000	2,500	3,000	23,675	28,675	150,000	175,000
Moss agate	2,500	2,000	950	950				1,500
Amethyst	2,100	2,100	2,100	2,500	98			200
Jasper				100				
Sunstone	350	300	150					
Fossil coral		1,000	2,000	3,000	700	700	1,000	1,000
Rutile	750	750						
Aquamarine					747		1,000	(a)
Rose quartz					600	200		200
Gold quartz	140,000	40,000	75,000	75,000	9,000	9,000	6,000	15,000
Rutilated quartz					30			
Dumortierite in quartz					250	250		
Quartz coated with chalcodony					4,000	2,000		500
Chrysoprase					200	200		100
Agatized and jasperized wood					53,175	6,000	2,000	10,000
Banded and moss jasper					630			
Fluorite					500	500		
Azurite and malachite					2,037			
Zircon (b)					16,000			
Gadolinite, fergusonite, etc. (b)					1,500			
Monazite (b)					1,000			
Spodumene (b)					200			
Wooden ornaments decorated with minerals (c)					15,500	15,500	15,000	15,000
Opal							5,000	10,000
Peridot							1,000	1,000
Miscellaneous minerals (d)					20,000	20,000	15,000	20,000
Total	209,850	118,850	163,600	139,850	188,807	118,833	235,300	299,000

a See Beryl.

b Including lithia emerald.

c Used to extract the rarer elements for chemical purposes.

d Such as clocks, horseshoes, boxes, etc.