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EIGHTEENTH ANNUAL REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY,

CHARLES D. WALCOTT, DIRECTOR.

PART V—Continued.

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EIGHTEENTH ANNUAL REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY.

PART V (continued).—MINERAL RESOURCES OF THE UNITED STATES, 1896, NONMETALLIC PRODUCTS, EXCEPT COAL.

PRECIOUS STONES.

By George F. Kunz.

INTRODUCTION.

The most important events in connection with precious stones during 1896 are (1) the presentation of some interesting conclusions by Prof. William H. Hobbs, who attributes the origin of the Wisconsin diamonds to the Green Bay lobe, or the Pigeon River district immediately north of it; (2) the publication of the interesting results of investigations by the late Prof. H. Carvill Lewis on the genesis of the diamond, which brings forth much strong evidence of its origin from the distillation of hydrocarbons in carbonaceous shales that have been penetrated by peridotite or other volcanic intrusions;[1] (3) the finding in quantity at Yogo Gulch, Montana, of sapphires of as fine a blue as the best Ceylonese gems, although scarcely over 1 carat in size, and of three small diamonds from the same State; (4) the continued finding of the green, red, blue, and multicolored tourmalines, and a perfect crystal, 10 inches long, at Haddam Neck, Connecticut; (5) the finding of large crystallized beryls, many of them of gem value, in the feldspar quarries at Topsham, Maine; (6) the continued output of fine turquoise in the Los Cerrillos and Grant County mines of New Mexico; and (7) the visit to the United States of Prof. Henri Moisson, whose interesting lectures and experiments on the production of artificial diamonds were of the greatest scientific interest, although these gems are as yet commercially unavailable.

DIAMONDS.

An additional contribution to literature upon the occurrence of isolated crystals of diamonds in Wisconsin, by Prof. William H. Hobbs, of the University of Wisconsin, appears in an interesting article in the Neues Jahrbuch für Mineralogie, 1896, vol. 11, pp. 249–251, with map, describing four localities; and, in a letter to the writer, Professor Hobbs describes two additional localities. One stone of $6\frac{3}{8}$ carats was found at Saukville, Ozaukee County, 6 miles northwest of Milwaukee, and another of $2\frac{1}{16}$ carats at Burlington, Racine County, the latter found by Mrs. G. Pufahl, of that place. These two stones were examined by Professor Hobbs and the writer. The larger stone is a flattened,

[1] These results are published in the volume on the Genesis of the Diamond, edited by Professor Bonney, of London.

distorted trisoctahedron; finely white in color, with two yellow stains; irregular, uneven surface, and with a deep octahedral impression on one side. It would perhaps cut to better advantage if it were cleaved, in which case it would probably produce two fine stones of over 1 carat each. The Burlington stone had a faint greenish color, which may be entirely exterior, as is the case with the diamond described from the Oregon locality. This crystal is an elongated twin, being tetrahedral in general form, and hence could be cut into a pear shape to better advantage than into a brilliant.

Professor Hobbs writes that the Saukville and the Burlington diamonds were found in the "Kettle moraine" of the Lake Michigan lobe, like the other Wisconsin diamonds referred to farther on. The Saukville stone is from the widened portion (interlobated) of the moraine between the Green Bay and the Lake Michigan lobes. The other is located on a cuspate portion of the moraine of the Lake Michigan lobe near the boundary of Illinois. These finds have considerable interest.

A diamond crystal was also found in 1886 by Mr. Louis Endlich, of Kohlsville, Washington County, Wisconsin. It was examined by Prof. William H. Hobbs, and found to be a rhombic dodecahedron of pale-yellow color, 20 millimeters in length and 13 millimeters in width, with an average thickness of 10 millimeters, and strongly resembling the stone found at Eagle, Wisconsin. The crystal is somewhat distorted. Its weight is 21 carats.

The diamonds found at Eagle, Oregon, and Kohlsville are of the same crystalline form, each having the faces of the dodecahedron showing vicinal planes of the hexakisoctahedron. The faces show also irregularities and depressed areas. The diamonds found at Eagle and Kohlsville are "Cape white," a very pale yellow; the one found at Oregon is almost white, with a faint greenish tint. In regard to their occurrence in Wisconsin, the interesting problem is readily solved on examining Professor Chamberlin's glacial map, where Eagle, Kohlsville, and Oregon are all seen to lie on the "Kettle moraine" of the later Glacial epoch. These diamonds were evidently transported from the north to the points at which they were found. If one studies from these points the ice movements as indicated by the traces of the glacier, one will readily see that these diamonds undoubtedly have a common origin, possibly in the northeastern part of the State, on the middle line of the Green Bay lobe, or perhaps in a still farther northeasterly direction. It is therefore of remarkable interest to find that along the State line, in the vicinity of the Menominee River, basic eruptive rocks are present in graphitic slates; and hence it is not improbable that the origin of the diamonds is of this character, as is the case in South Africa. The locality is one that has been little searched, and it is highly probable that diamonds may yet be found there. The diamonds of the Plum Creek district apparently differ in their source, although they were found only a few miles from the Kettle moraine, and may possibly have been washed out of the Menominee under the glacial action in this region; but they probably had their source in the region of the Pigeon River, where the geological conditions are identical with those observed on the Menominee.

There were recently for a time in the possession of Mr. H. Vreeslander, of New York City, three diamond crystals sent by Mr. A. F. White, of Butte, Montana, and claimed to have been found in that State. One was a trigonal trisoctahedron, $1\frac{3}{16}$ carat, with large oval markings over the entire crystal, which was of a faint yellow; one side of it was broken. The second was an octahedron of one-sixteenth carat, with rounded faces, an apparent twinning being visible on the edges; this was also a faint yellow in color. The third was an acute octahedron of one-thirty-second carat, with dulled faces, giving it a ground-glass effect, and showing a considerable growth on the octahedral faces, although the edges of the crystal were long and not so well developed. Some investigation is to be carried on at the locality.

The annual reports of the condition and production of the great South African diamond mines have been presented with extreme fullness. The leading points of general interest are summed up and included here, this being so important an element in the world's production of gems.

The following statement of the condition of the diamond-mining industry is gathered from the admirable report of Mr. Gardner F. Williams, manager of the De Beers Diamond Mining Company, Limited, and formerly of Oakland, California:

The two leading mines, the De Beers and the Kimberley, the only ones that are much worked at present, give the following statistics for the year ending June 30, 1896:

The output of "blue-ground" at the De Beers mine was 1,554,225 loads (16 cubic feet to a load); at the Kimberley mine 1,143,884 loads (together with 67,470 loads of "reef-rock" or waste); the total for both being 2,698,109 loads of blue-ground, as against 2,525,717 for the year before; an increase of 101,083 loads. The cost per load at the De Beers mine was 4s. 7.7d., as against 4s. 3.6d. the previous year; at the Kimberley mine 4s. 10.3d., as against 6s. 2.6d. the previous year. On June 30, 1895, there were in sight at the De Beers mine about 3,300,000 loads of blue-ground. As new workings have been carried down, the amount revealed between the 1,000 foot and 1,200-foot levels is estimated at 4,400,000 loads; giving a total of 7,700,000 loads. Deducting from this the output (as above) of over 1,500,000 loads, there remain fully 6,000,000 loads in sight; an amount equal to about four years' demand.

At the Kimberley mine at the close of last year some 1,800,000 loads were in sight above the 1,200-foot level; the carrying down of the "Prospect shaft" to 1,520 feet and the opening of intermediate levels every 40 feet have revealed about 3,300,000 loads more; making in all over 5,000,000. Deducting the output for the year of somewhat over 1,000,000 loads (as above), leaves about 4,000,000 loads now in sight; again about four years' supply at present rates of output.

At the De Beers mine the water removed amounted to an average of 3,877 gallons per hour, as against 5,231 the previous year; at the Kimberley, 7,894 gallons per hour, as against 9,882 before. A tunnel has been carried around this mine at the top of the melaphyr, to prevent surface water from getting down into the loose débris in the open mine; this has proved very successful, and no "mud-rushes" have occurred since.

The De Beers mine has not been deepened, the "rock-shaft" remaining at 1,233 feet; but a tunnel on the 1,200-foot level has been completed, and the main rock-chute from the levels above connects with it. This tunnel, 955 feet long, was driven to the northeastern side of the mine, in order to give better ventilation to that portion of the workings, and has had the desired effect. The Kimberley mine has reached the greatly increased depth of 1,585 feet on the "Prospect shaft" above mentioned, and levels have been opened in this deep portion every 40 feet.

The following table gives the amount of "blue-ground" brought up and placed for treatment:

Amount of "blue-ground" brought up and placed on the floors ready for treatment.

	De Beers.	Kimberley.	Total.
	Loads.	*Loads.*	*Loads.*
On June 30, 1895	1, 974, 127	725, 106	2, 699, 233
Output for the year	1, 554, 225	1, 143, 884	2, 698, 109
Total	3, 528, 352	1, 868, 990	5, 397, 342
Washed and crushed during the year	1, 565, 631	1, 031, 395	2, 597, 026
Remaining June 30, 1896	1, 962, 721	837, 595	2, 800, 316

A considerable amount of the material remaining on the floors is of the kind known as "hard blue," or "lumps," which does not readily disintegrate by exposure. Much of this, however, is now crushed by improved machinery.

The output from the De Beers mine has been materially reduced by scarcity of native labor and by interruption from "mud rushes" on certain of the levels, surface water getting access to the loose material and breaking into the workings.

The 2,597,000 loads of material washed and crushed during the year from the two mines yielded 2,363,000 carats of diamonds; so that the average yield has been 0.91 carat per load, as against 0.85 carat for the year previous. The total cost of mining and washing has averaged 7s. 0.1d. per load, as compared with 6s. 10.8d. the year before.

As diamonds are now valued at the general rate of about 30s. per carat, the proceeds, on the basis of 0.91 carat per load, would be about £1 7s., from which the cost of 7s. a load is to be deducted. The company, however, did not realize quite this amount, as they contracted with a syndicate to take the entire yield of the year at 27s. 6d. per carat. The net proceeds, therefore, as given in the report of Mr. Cecil Rhodes, are £1,900,000.

One very large diamond was obtained at the De Beers mine, on the 840-foot level, in June last. It was a pale-yellow octahedron of 503¼ carats, but somewhat flawed and cracked. In size this is the largest stone yet obtained from the mines of this district.

In his report Mr. Cecil Rhodes dwells on the financial history of the De Beers Consolidated Company since its formation in 1888. It then owed £5,000,000; its indebtedness now is £3,500,000. In the interval it has not only paid large dividends, but has bought £1,250,000 worth of consols, and has purchased the Wesselton, Gordon, Bulfontein, and Dutoitspan mines. These acquisitions, which comprise all the important mines immediately adjacent, and are now nearly complete, have been made with the profits alone, and not by any increase of capital. In the last year, out of the net profit of £1,900,000, the amount paid in dividends was £1,500,000, and the rest has been spent for expenses and the purchase of the new Gordon mine. The diamonds obtained were all taken by a syndicate at 27s. 6d. a carat, up to 200,000 carats a month. This syndicate has its branches and connections all over the world, and disposes of the diamonds at a profit. The same arrangement has been made with it to June 30, 1897, and an option extended to December 31.

A curious feature reported by a correspondent of the Jeweler's Circular, September 23, 1896, page 7, is the fact that great numbers of valuable diamonds are in the possession of native African chiefs, often far remote from the mines. These were accumulated in former years, when supervision was less thorough and the native laborers had large opportunities for theft. Many were sold to the "I. D. Bs." (illicit diamond buyers) on the spot, but many also were retained and taken home by the men on their return to their tribes; and these for the most part went into the hands of the negro chiefs. Indeed, it was often made a condition by a chief that anyone of his people who went to work in the mines should bring him back a diamond as a present; and this condition was enforced by severe punishment, or even death, in case of failure. As a consequence, many of the chiefs obtained numbers of fine stones, which they treasure more as charms or talismans than for their commercial value, of which they had little knowledge. Of late some enterprising parties have made long journeys into the uncivilized regions, with no little risk and hardship, to endeavor to procure some of these diamonds by barter. In some cases the chiefs refuse to sell at all; in others they demand impossible prices; but some have been obtained, chiefly for liquor, and especially for guns. One trader thus procured six diamonds of more than 200 carats each; and a small company has secured in four months diamonds worth £35,000 at the mines.

In the Bingara diamond field, according to the report for 1895 of the department of mines and agriculture of New South Wales, some work is going on steadily, and the new locality, Boggy Camp, has attracted a good deal of attention. Some 300 acres of diamantiferous "ground" had been taken up here, and several parties were actively operating. Only two of these had obtained important results up to the end of 1895, one having taken about 3,000 stones from the washings, and the other 1,100. The total value of these is about £400. They are not large, averaging about three to a carat, though a few have been found of greater size, up to 2 carats. For these rather small diamonds there is not very much demand, and as the deposits have been known and worked more or less for some years, it does not seem likely that they contain many large stones or can become important factors in the world's diamond supply. The stones are washed from a pebbly drift, overlain by basalt, and resting upon granite; the drift also yields some tin ore. There seems to be a large development in New South Wales of a condition similar to that of the "sublava" gravels of California, old river channels filled by igneous outflows, and yielding gold, platinum, and here diamonds, being described in various parts of the colonial report. Comparing the conditions with those of South Africa, the Government geologist, Professor Putnam, states that the area occupied by the diamond-bearing river drift is quite extensive, and he believes that the source of the diamonds will, in time, be traced to volcanic "pipes," as at Kimberley, but that the area is so largely covered by the basaltic flows that the pipes are concealed from observation.

To those interested in the use of the diamond for industrial purposes the following fact may be of interest:

In reference to bort, which is extensively used for slicing, engraving, and polishing, a case has recently come up in the New York customhouse from which it appears that this name, or that of diamond dust, is to some extent used commercially for a polishing powder composed of lime and silica. A New York firm imported some of this material under a name which was translated "polishing powder" in the invoice, and then objected to paying the 2 per cent duty upon it, on the ground that it should be admitted free, as diamond dust or bort. Analysis showed its composition, but the importer testified that it was commercially known as bort or diamond dust. The decision was, that even were this the case, the provision for free admission was intended only for the real bort, and should not cover other substances that might be merely so called—presumably for the purpose of evading the duty.

In the report of the department of mines and agriculture of New

South Wales for 1895 is a valuable report upon diamond drills, their use, results, and cost. The department has a superintendent of diamond drills, Mr. W. H. J. Slee, under whose direction drills are rented and operated, and who presents and tabulates the year's work. In 1895 the entire depth bored was 299 feet, scarcely more than half that in the year previous. The total cost for boring was somewhat reduced, being $7.34 instead of $8.73 per foot. The amount of diamonds used, however, was very much greater, their value being 90 cents per foot, as against 18 cents per foot the year previous—a result due to great hardness in the rock bored. The average rate of boring was 9.34 inches per hour; most of it a 4-inch bore through porphyry, in the gold mines at Captains Flat.

A writer in the Engineering and Mining Journal gives a description of a simple outfit for a miner or prospector looking for diamonds in placer beds. After classifying the gold and diamond placers of Brazil and California under three groups, as (1) surface and ravine diggings (the "dry diggings" of the first African discoveries), (2) river beds, either at low water or exposed by artificial diversion (the "river diggings" of Africa), and (3) ancient river beds, covered by volcanic outflows or otherwise no longer occupied by streams, he recommends to the diamond seeker the following outfit: A light pick, a shovel, a "miner's wallet," or long bag for carrying the gravel, etc., to water (size 4 feet 8 inches long by a foot and a half across), and two screens or "riddles" with meshes of three-fourths and one-eighth inch, respectively, together with a tub for washing, easily made by cutting a barrel in half, or else a rubber bath tub, and a sheet of rubber cloth to sort the washed gravel upon. To examine it he should have a watchmaker's lens (two powers) and a hardness scale, made by fixing a chip of diamond, one of corundum, and one of quartz, with lapidary's cement, into the end of a piece of glass tubing or of a pencil from which the rubber has been removed. The lapidary's cement melts easily over a spirit lamp, may then be easily molded with the fingers, and becomes very hard and firm.

To examine for diamonds, the coarse riddle is fastened above the fine one, the gravel put into the upper one, and all immersed in the tub and washed and shaken. The coarse stones are retained in the upper riddle, and the sand and earth pass through both into the tub, leaving all the finer gravel in the lower riddle. This latter is detached from the other, and its contents are again washed and shaken, till the heavier portions have settled at the bottom; it is then quickly turned out on the rubber sorting cloth, which should be spread close by. The heavier stones will then be on the top, and may be examined with the lens and the hardness scale.

The writer of the article states that he has had much experience in the Brazilian placers, and believes that such simple directions will have value, as there are frequent inquiries from miners and prospectors, and very little definite information is to be found in published authorities.

To the above-described outfit may be added a simple silver, iron, or bronze ring, with a natural octahedron of diamond brazed in it for a hardness test; also some sheets of emery paper, or paper coated with carborundum, so that when a stone is found that resembles a diamond, if it be rubbed for a few moments on the paper and any visible mark be made on it, one can be sure that it is not a diamond.

During 1896 a long trial was conducted in the United States circuit court to determine whether or not certain firms had violated the contract-labor laws by bringing in diamond cutters and polishers. It was decided in the negative. During this trial a large amount of valuable testimony bearing on the history of diamond cutting in the United States was taken, nearly everyone who had ever engaged in this industry being called upon to testify.

The remarkable discovery of Prof. Henri Moisson, of the Institute of France, alluded to in the last report (page 904), of a method for producing diamonds artificially by the rapid cooling of highly carbonized iron from fusion at very high temperatures, whereby the exterior is solidified, and the interior thus becomes subject to an enormous pressure, has not led to any commercial results, as the diamond crystals thus obtained are extremely minute. But it has great scientific interest and has been drawn into relation also with the occurrence of diamond carbon in meteorites. At the reception tendered him October 27, 1896, by the united scientific societies of New York, Professor Moisson performed his classic experiment of producing artificial diamonds by the method described in the last report. He was successful, and at the time stated that he had performed the experiment 300 times without failure, but that not more than one-half of a carat of diamond was produced by the 300 experiments.

Professor Rossel, of the University of Berne, has undertaken an inquiry as to the possible presence of diamond carbon in very hard steels, and in some extremely tough varieties of iron from the bottom of blast furnaces, where the pressure is very great. The result has proved the correctness of this suggestion, as Professor Rossel has obtained from such sources minute particles having octahedral crystallization and presenting all the physical properties of diamond. The largest of these do not exceed half a millimeter in diameter, but they suggest the possibility of more important results in the course of future experiment.[1]

Among various fraudulent schemes resorted to for the purpose of deceiving the public regarding diamonds, a notably ingenious one has been exposed during the past year. Certain parties operating in Philadelphia as a center, and claiming to have branches in New York and other cities, by large signs and extensive advertisements in the papers, announced extraordinary opportunities for procuring genuine diamonds at $1 each, and had a display window filled with the supposed gems in

[1] Journal Officiel Illustré de l'Exposition Nationale Suisse, 1896.

showy settings. Every tenth stone was to be a real diamond; the rest were announced as "genuine white topaz, impossible to detect from diamond." Experts were "defied to distinguish them," etc. The Pennsylvania Retail Jewelers' Association, through its officers, undertook an investigation and laid the facts before the district attorney as a fraudulent lottery. The "white topaz diamond" proved to be cheap paste, and the settings to be 5-carat gold only. As to the one-tenth of true diamonds no evidence was obtained, and their existence was highly uncertain. Proceedings have also been begun against the same party for similar practices in Cleveland and Providence, the claims aggregating over $12,000. This system of deception has been set on foot in nearly every large city in the United States.

GENESIS OF THE DIAMOND.

There has recently been published a volume of small size, but of especial interest and importance, in regard to the origin of diamonds. This is none other than the posthumous issue of the full papers of the late Prof. H. Carvill Lewis, edited by his friend, Prof. T. G. Bonney, of London.[1] It will be remembered that Professor Lewis was the first to present a clear and definite theory of the origin of the South African diamonds, as resulting from the intrusion of igneous rocks into and through carbonaceous shales, and the crystallization of the carbon throughout the rock as it cooled, from hydrocarbons distilled from the shale that had been broken through. These views, now for the most part accepted, and subsequently confirmed by other and very interesting parallel discoveries, he presented in two papers read before the British Association for the Advancement of Science at its meetings held in 1886, at Birmingham, and in 1887, at Manchester. Before he was able, however, to prepare them for publication and carry them to the greater completeness that he desired, Professor Lewis succumbed to an attack of typhoid fever, which removed one of the most brilliant and capable of the rising scientists of this country. Agreeably to his expressed wishes, his material was intrusted to his friend and colaborer, Prof. George H. Williams, of Johns Hopkins University; but by a strange fatality, before the latter had time to arrange and edit these papers, he too fell a victim to the same disease in 1894. The work was then committed to Professor Bonney and is at last given to the scientific world.

The book consists of an introductory note by Mrs. Lewis; a preface by Professor Bonney; the two papers of Professor Lewis himself, with some later notes and references by the editor; a brief account of similar material from other localities, belonging to Professor Lewis, also by

[1] Papers and Notes on the Genesis and Matrix of the Diamond, by the late Henry Carvill Lewis, M. A., F. G. S., professor of mineralogy in the Academy of Natural Sciences, Philadelphia, professor of geology in Haverford College, U. S. A. Edited from his unpublished MSS. by Prof. T. G. Bonney, D. Sc., LL. D. F. R. S., etc. Longmans, Green & Co., London and Bombay, 1897. Pages xvi, 72. 2 plates.

the editor; a closing note on some other manuscripts of Professor Lewis, and a full index. There are also two plates and a number of smaller illustrations, the latter from Professor Lewis's own drawings.

The first paper, "On a diamond-bearing peridotite and on the history of the diamond" (1886), is brief, dealing with the general character and occurrence of the diamantiferous rock at Kimberley and outlining Professor Lewis's theory.

The second paper, "The matrix of the diamond" (1887), is more extended, and goes into an exhaustive discussion and comparison of the various aspects, contents, and alterations of the rock, which he finds to be different from any previously described, and therefore proposes for it the name kimberlite. Its main character is that of a highly basic porphyritic peridotite, filled with olivine crystals and grains, more or less altered, and various other minerals, serpentine, tremolite, etc., with bronzite, rutile, perofskite, pyrope garnets, micaceous minerals, and other forms, and at times brecciated in structure, filled with fragments of carbonaceous shale brought up from below. The shales are of Triassic age, the "Karoo beds" of that region, and the intrusion of the peridotite in the great "pipes" or chimneys that constitute the mines is therefore proved to be of a later, though not exactly determined period.

The question has sometimes been raised whether the diamonds themselves may not have been carried up from a deeper source in rock below, instead of originating in the peridotite, and the occurrence of broken crystals has been cited in support of this view. Professor Lewis, however, disposes very completely of this idea in two ways: He refers to the well-known fact that each of the great mines or "pipes" yields diamonds that have, in some respects, a type or character peculiar to that one and different from the others; so that African experts, and even those who have never been there, can recognize from which mine any diamond has come. Further, as to the broken crystals, he shows that breakage not unfrequently occurs after the diamonds are removed from the rock, and points out that this is a result of strain in their formation, as indicated by microscopical and optical examination, and that such a condition is known to produce ruptures and explosions in other minerals. It may be added here, although Professor Lewis does not speak of it, that many crystals must be broken in the blasting of the rock, the shoveling and carting of the loosened material, and the various mechanical processes employed at the mines, and that pieces of such broken crystals would be separated and scattered to various parts of the dumping floors, never to be recognized as fragments of the same one when finally recovered perhaps at very different times.

The rock itself is a dark green compact material, resembling serpentine, and containing a large proportion of olivine in grains and crystals; several green minerals that, from the resemblance of their color, are not conspicuous from the ground mass (enstatite, chrome-diopside, smaragdite, and bastite); a mica, probably biotite, more conspicuous and quite abundant, and frequent grains of pyrope garnet, sometimes of gem quality and miscalled "Cape rubies." Of smaller disseminated minerals are to be noted perofskite, quite frequent, and magnetite, chromite, ilmenite, and picotite, less so, though common. Rare and minute occurrences are apatite, epidote, orthite, tremolite, tourmaline, rutile, sphene, and leucoxene. As decomposition products there are serpentine and calcite, abundant, and zeolites, chalcedony, and talc, also cyanite (?). These, with the diamonds and the included fragments of carbonaceous shale, make up the contents of this remarkable rock.

Professor Lewis then goes into a detailed account of the mode of occurrence of these minerals, beginning with the most conspicuous species—the olivine—which is remarkable for its fine cleavage surfaces and very interesting in its alterations. These are chiefly (1) into serpentine, proceeding from without inward, and penetrating along crevices and fractures, also sometimes in the form of chrysotile, producing a velvety border or coating to the grain; (2) tremolite, more internal, the fibrous structure developing parallel to the vertical axis and domes of the olivine crystals; (3) when both these alterations are present and have gone so far as to obliterate most or all of the olivine, a talc-like substance intervenes between them, in which are developed minute needles of rutile, arranged parallel to the faces of the olivine crystal. The rock contains every stage of these changes, from pure bright unaltered olivine to those forms that have borders of serpentine or chrysotile, or incipient tremolite fibers within, to the complete alteration just described. The relation of all these to similar phenomena in other rocks and in meteorites is discussed with much fullness.

Professor Lewis then takes up the smaragdite, chrome-diopside, bastite, and enstatite (or bronzite, for it is just on the line between the two varieties). The two first named are, in some cases, fine enough in color and clearness to yield gems, and also sometimes the bronzite. All are colored by chromium. The diopside occasionally gives rise to calcite by alteration.

The mica is next considered. As all who are familiar with the rock are aware, it is the most prominent of the contained minerals to the eye. It is somewhat anomalous in character, being chemically a biotite, but optically nearer to phlogopite. It occurs in several distinct ways: (1) as included crystalline masses or plates, apparently an original ingredient of the rock; (2) surrounding grains of pyrope; (3) rarely as a result of the alteration of enstatite; and (4) as a metamorphic product from the included fragments of shale; and the first form has produced, by hydration, the vermiculite variety called vaalite, which occurs freely in the decomposed peridotite so largely known as the "blue-ground."

After referring to the pyrope garnets, and suggesting that the various garnetiferous serpentines are doubtless derived from the decomposition of similar peridotites, as further indicated by their likewise containing olivine, bronzite, chrome-diopside, etc., the author mentions another variety of garnets as found in this rock, very small, very brilliant, very hard, colorless or greenish, and extremely difficult to distinguish from small diamonds. These he is inclined to refer to demantoid.

The remark is made that while perofskite is familiar in various nonfeldspathic igneous rocks, it has not been found in peridotite until Professor Williams recognized it in the peculiar rock from Syracuse, New York, and that later Professor Lewis identified it in the similar rock from Isoms Creek, Kentucky, where it had been previously regarded as anatase. These three rocks—those just named and the African—are the only known occurrences of what is here named kimberlite.

After going into some particulars as to the minor minerals found in this rock, Professor Lewis then takes up the base or ground mass and discusses it minutely. He terms it "a more or less homogeneous serpentinous mass," very difficult to study by reason of its decomposed condition, consisting now of a mixture of serpentine with calcite and some other products of alteration, the original structure being wholly lost.

Fragmental inclosures are frequent, "both of the adjoining shale and diabase, and also of more deeply seated granite, gneiss, eclogite, and other related rocks." Of these the shale predominates, sometimes making the rock a breccia. The shale itself is highly charged with carbon, so as to be quite combustible; but the included fragments are altered, having lost their carbon and become harder, sometimes even metamorphosed to a micaceous structure, as before referred to. In size they vary from large masses, in the upper part of the mines, called by the workers "floating-reef," to small fragments, diminishing in number and size in descending.

The author goes into a detailed petrographical and chemical discussion as to the original character of the rock, in which it is hardly possible to follow him in a review, and finding no known rock that presents identical characters, he proposes for it the name kimberlite. This he designates as "a porphyritic volcanic peridotite of basaltic structure," and notes three forms of its occurrence: (1) kimberlite proper, a typical porphyritic lava; (2) kimberlite breccia, the same rock broken and crushed by volcanic movements and crowded with included fragments of shale; (3) kimberlite tuff, the fragmental and tufaceous portion of the same rock. These varieties graduate into one another, and all occur together in the same neck or crater, the second, however, being most abundant and most productive of diamonds.

He treats of the origin of the brecciated structure, which has caused much discussion, some geologists regarding the whole rock as a sort of tufa or volcanic mud, while others hold that it is a true outpouring lava that has carried up fragments of the rocks broken through in its course, and has since been largely decomposed. Professor Lewis urges the latter theory strongly and supports it by many arguments, while the editor, Professor Bonney, evidently inclines to the other view, advocated by Prof. W. H. Huddlestone in 1885, and by some others. There is not space here to review Professor Lewis's several arguments for the true igneous character of kimberlite and against the tufaceous theory. The one to which Professor Bonney accords chief importance is the identity of the rock with that from Syracuse, New York, and Elliott County, Kentucky, where it occurs in actual dikes, such as are not found in tufas. The brecciated character which is so marked is referred by Professor Lewis to three causes, acting either separately or perhaps together. These are (1) rapid cooling and shrinkage; (2) "friction brecciation," from contact with the wall-rock, and (3) subsequent movements and explosions in the crater itself, below. He illustrates and parallels the first of these from meteorites, to some of which this rock bears marked resemblance both in structure and in contents, and the others from well-known occurrences in terrestrial volcanic rocks.

The third section of the volume is occupied with a detailed account, from specimens and notes of Professor Lewis, of the two other known occurrences of kimberlite, at Syracuse, New York, and Willard, Kentucky. The identity of these with the African rock, in almost all particulars, is remarkable, and as they form definite eruptive dikes Professor Lewis's views as to the latter are strongly confirmed.

It remains only to call attention to other and later facts which tend to bear out the views presented in this remarkable posthumous article.

The presence of a residual hydrocarbon in the rock of the African diamond mines was shown by an interesting and important observation of Sir Henry E. Roscoe,[1] which is alluded to by Professor Lewis in his second paper and has frequently been cited in discussions of the subject. He found that the "blue ground," on treatment with hot water, yielded an aromatic hydrocarbon, which he was able to separate by digesting the blue ground with ether and evaporating the solution. It then appeared as a crystalline aromatic solid, burning with a smoky flame (showing it rich in carbon), volatile, and melting at 50° C.

The bearing of this fact on Professor Lewis's theory is clear. He holds that the igneous rock, breaking through the highly carbonaceous Karoo shales (37.5 per cent of carbon,)[2] became charged with volatilized hydrocarbons distilled from the shale, and that in cooling these had crystallized, partly into diamonds and partly into the many carbonadoes, larger and smaller, which are distributed through the rock. Professor Roscoe's material strongly confirms this theory, which indeed he himself propounded.

Daubrée's discussion of the analogy of the occurrence of diamond in meteorites and in the South African kimberlite appeared in the Comptes Rendus, 1890, pp. 110–118.

On September 22, 1886, a meteorite fell at Novo Urei, in the province

[1] Proc. Lit. Philos. Soc. Manchester, Vol. XXIV, 1885, p. 5.

[2] J. E. Whitfield, analyst; see Gems and Precious Stones of North America, by G. F. Kunz, 1889, p. 33.

of Pensa, Russia, which was found to contain about 1 per cent of diamond carbon in the form of gray particles.

In 1887 Mr. Fletcher[1] described the new mineral, cliftonite, a black substance with a hardness of 2.5 and a density of 2.12, occurring in cubes with faces of the dodecahedron or tetrahexahedron in the meteorite of Youndegin, West Australia. This suggested a graphitic alteration of diamond, a view taken by Brezina[2] regarding this new species and certain graphitic crystals of cubic type observed long before in the Arva meteorite and regarded as pseudomorphs after pyrite by Haidinger,[3] but later by Rose as after diamond.[4] Similar crystals were also known in the Sevier iron of Cocke County, Tennessee.

In 1891 the discovery of diamond, or at least of diamond carbon, in some quantity in the meteoric iron of Cañon Diablo, Arizona, was announced by the late Prof. A. E. Foote[5] and Dr. George A. Koenig. In July, 1892,[6] Dr. O. W. Huntington gave further experiments on the same material, confirming the determination of Professors Foote and Koenig; and in December of the same year similar results were published by Mr. M. C. Friedel.[7] A crucial test was then proposed by the author and carried out in the presence of Dr. Huntington at the World's Fair at Chicago, September 11, 1893, namely, the cutting of polished faces on pieces of diamond with some of the carbon powder from the cavities of the Cañon Diablo meteorite.[8]

In the meantime Prof. Henri Moisson, of Paris, had been making his now celebrated experiments on the artificial production of diamonds from the cooling, under extreme pressure, of highly carbonized iron fused in a specially constructed electric furnace.[9]

All these facts, taken together, form a remarkable series of confirmatory evidence for the views advocated by our late countryman in regard to the production of this most precious of gems, the origin of which has been so obscure a problem in mineralogy and geology. Another point of great scientific interest developed in the course of these investigations is the close similarity, both in composition and in structure, existing between some of these rarer igneous rocks of our globe and the extra-terrestrial visitants that come to us from space.

It is a matter for national pride that this remarkable investigation should have been made by an American scientist; and a deep debt of gratitude is due both to the English editor, Professor Bonney, for this labor of love alike to science and to a deceased friend, and to Mrs. Lewis, who has so carefully sought to preserve and to make public these papers of her brilliant and lamented husband.

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[1] Mineralogical Magazine, Vol. VII, p. 121.
[2] Ann. Mus. Wien, Vol. IV, 1889, p. 102.
[3] Poggendorff, Annalen, Vol. LXVII, 1846, p. 437.
[4] Beschr. Meteor., 1864, p. 40.
[5] Am. Jour. Sci., 3d series, Vol. XLII, 1891, pp. 413-417.
[6] Science, p. 15.
[7] Bull. Soc. Française de Minéralogie, No. 9, p. 258.
[8] Am. Jour. Sci., Dec., 1893, 3d series, Vol. XLVI, and Mineral Resources for 1893, pp. 683-685.
[9] Mineral Resources, 1895, pp. 903, 904.

RUBY.

NORTH CAROLINA.

Concerning the discovery of true rubies in the Cowee Valley, in Macon County, North Carolina (first noticed in Mineral Resources for 1893, p. 693; more fully in that report for 1894, p. 599, and again last year, p. 905), it is of interest to state that this locality has lately been visited and examined by the eminent authority, Mr. C. Barrington Brown, whose joint article with Professor Judd [1] on the ruby mines of Burma was reviewed in this report for last year.[2] The results of this investigation are to be presented to the Royal Society of London in a similar article by the same two eminent authorities, and it is hoped that it may be published in time to embody the main features of it in the next issue of this report.

At present all that can be stated as to Mr. Brown's conclusions is that the manner of occurrence of the rubies here is claimed to be new to science, and to have important bearings upon the genesis of the Burmese gems.

Prospecting has been extended for over 3 miles up and down the Cowee Valley, and the "bottom" and "hillside" gravels have been shown to be ruby-bearing throughout. At one point near the head of the valley the gems have been found in situ, and prospecting is in progress to determine the nature and extent of this occurrence.

Associated with the rubies are found various minerals, notably some very beautiful almandine garnets, which yield cut gems of remarkable brilliancy and color. There are also found gray, blue, and magenta corundum, and small quantities of gold, sperrylite (platinum arsenide), monazite, zircon, and rutile.

The best ruby crystal thus far obtained here weighs about 6½ carats, and is claimed to be of fine quality. It has not yet been cut, however, and its gem value can not definitely be determined. It is believed by those engaged in developing this locality that a veritable ruby-bearing district, similar to that of Burma, has at last been discovered in North Carolina, but under conditions unexpected and novel in character.

BURMA.

In a paper recently presented before the Institution of Mining and Metallurgy of London, Mr. T. Trafford Wynne has given very full accounts of the history and methods of mining in the ruby district of Burma, in the Mogok Valley. Much of his description, though with some little variation of detail, is substantially identical with that given in the report of Messrs. Brown and Judd, referred to above. He describes the three native methods in much the same way: The "Twinlones," or

[1] Philos. Trans. Royal Soc. London, Vol. CLXXXVII, 1896, pp. 152–228.

[2] Seventeenth Ann. Rept. U. S. Geol. Survey. Part III (Mineral Resources), 1896, pp. 905–906.

"Twins," pits dug in alluvial deposits down to the gem gravel, for which he uses the native name *Byon;* the "Hmyaws" (hmyaudwins of Brown and Judd), a sort of hydraulic mining of the hill wash, or alluvium along the hillsides; and the "Loos" or "Loo-twins," i. e., cave mines, where the gems are gathered from fissures and cavities in the limestone rock. The chief points in which Mr. Wynne's account varies from the other are in the statement that the alluvium has been subjected to a sort of natural riffling process, by ridges of rock crossing the valleys, over which the lighter and finer material has been carried, while the coarser and heavier, containing the gems, has been retained above them; and in his account of the Hmyaw-twins, or "Water-mines," wherein he states that the cutting down of the banks is done by hand and the water allowed to fall from as great a height as possible upon loosened masses of clay and gravel, carrying the disintegrated material into boarded channels, where it is stirred with hoes, etc., and the heavy "Byon" caught in a box at the lower end, and the light mud washed away. The "Byon" is then picked over by hand.

He adds that this form of mining is chiefly in the hands of the headmen of the villages, as there is considerable expense to be met in making ditches and bamboo flumes, etc., before profits can be realized.

Mr. Wynne then goes on to give later accounts of the introduction of European methods. The English company that now holds the mining rights from the Government made various attempts with little result for some time, but finally established a successful experiment in working at the lower end of the Tagoungnandine Valley. Here there was available a 100-foot head of water power. This was employed to drive a 4-foot Pelton wheel pump at the mining pit. As it was found to work successfully, the same method is being extended into the main valley of the Mogok. Another process is also employed at one point—that of tunneling through the rock barrier that obstructs the drainage of the valley and causes it to hold so much water in the soil. The tunnel was 10 by 10 feet and 500 feet long, and drained the valley to a depth of 40 feet; a washing plant was erected there, driven by water power. The total cost of excavating, hauling, washing, and sorting for a load of 15 cubic feet is a little over half a rupee. This method, of course, is available only in the smaller valleys, where the rock barrier is narrow.

This same paper and various other recent references mention the discovery of a ruby district at a point known as Nanyaseik, some 60 miles northwest of Mogoung, where fine gems are reported to occur through a considerable area. No very definite accounts of this region are yet attainable, but some parties connected with the Burma ruby mines have visited it and report that it is likely to prove a serious rival to Mogok.

SAPPHIRE.

MONTANA.

The existence of sapphire in the State of Montana has been known for some years past, and has attracted considerable attention. Several localities are now known, and several distinct modes of occurrence. They were first found in transported gravels along the bars of the upper Missouri; then they have been found in the earthy product of decomposed dikes, and lastly farther down in the unaltered igneous rock itself, the succession thus presenting a close parallel to the history of the diamond workings in South Africa.

The first published description of the Montana sapphires was by the late Dr. J. Lawrence Smith.[1] He said:

> These pebbles are found on the Missouri River near its source, about 61 miles above Benton. They are obtained from bars on the river, of which there are some four or five within a few miles of each other. Considerable gold is found on these bars, it having been brought down the river and lodged there, and the bars are now being worked for gold. The corundum is scattered through the gravel (which is about 5 feet deep) upon the rock bed. Occasionally it is found in the gravel and upon the rock bed in the gulches, from 40 to 50 feet below the surface, but it is very rare in such localities.

A fuller account of the conditions and yield was given by the author in his volume on Gems and Precious Stones of North America, published in 1890 (pp. 48–49). He subsequently visited the locality and examined it carefully, publishing the results in the appendix to the same work (pp. 340–342).

In 1891 the first serious attention began to be paid to the mining of sapphires in this district. The bars consist of an auriferous glacial gravel, and in working them for gold, sapphires were obtained as a by product. By 1890 companies began to be formed and claims taken up and examined with a view to sapphire mining. The region extends for some 6 miles along the Missouri River, the central point being Spokane Bar, 12 miles east of Helena. Other names, such as Emerald Bar, Ruby Bar, French Bar, Eldorado Bar, etc., were given to different points of the area. The gravel rests on a slaty bed rock and contains a variety of minerals besides gold and sapphires—small crystals of white topaz; garnets in rounded grains, often of rich color and miscalled rubies; cyanite; stream tin; chalcedony; limonite pseudomorphs after pyrite nodules, etc. At Ruby Bar two facts of great significance were encountered bearing on the age of the gravel and the source of the gems. The writer saw and measured a mastodon tusk 3 feet long, embedded in the sapphire layer of the gravel; and a dike was found cutting the slaty bed rock beneath, in which were crystals of sapphire, pyrope, and sanidin. All these facts were described by the writer,[2] together with an

[1] Am. Jour. Sci., Sept., 1873, 3d series, Vol. VI, p. 185.
[2] Mineralogical Magazine, London, Vol. IX, 1891, p. 396.

account of the rock, by Mr. H. A. Miers,[1] who characterized it as a "vesicular mica-augite-andesite," abounding in brown mica and porphyritic crystals of augite, with a ground mass of feldspar microlites and brown glassy interstitial matter, with magnetite.

Two years before, indeed (in 1889), the writer had seen some specimens of a trachytic rock, inclosing well-defined crystals of sapphire similar to those of Eldorado Bar, from a dike somewhat farther up the river. These facts, which were referred to in Gems and Precious Stones of North America (p. 49), and the appendix (p. 341), sufficiently showed the source of the gems as coming from the erosion of dikes of igneous rock.

More recently sapphires have been found throughout a considerable district lying some 75 to 100 miles east of the Missouri bars, the principal point being Yogo Gulch, on the Yogo Fork of Judith River, near its headwaters, in Fergus County, Montana, on the eastern slope of the Little Belt Mountains. The nearest town is Utica, 15 miles to the northwest, in the same county. The sapphires occur over a somewhat extended area, which is being explored and laid out in claims. They are embedded in a yellow earthy material, from which they may be washed out by sluicing, as for gold, the heavy crystals gathering at the bottom. Mr. S. S. Hobson, of Great Falls, Montana, the original discoverer of the gems at Yogo Gulch, states that there are at that point two dikes containing sapphires, which have been traced for a distance of 7,500 to 8,000 feet in an east-west course, about 800 feet apart. One of these is 75 feet wide, and consists of "yellow earth" (i. e., is completely decomposed). It has been found that what was supposed to be the end of the "vein" is really a 50-foot fault, and that the vein can be traced very much farther. In working down to a greater depth the unaltered igneous rock has been reached. These Yogo Gulch sapphires have been referred to by the writer in the Sixteenth and Seventeenth Annual Reports of the United States Geological Survey.

Other localities are also coming to light in the same State. One of these is at Rock Creek, Granite County, 30 miles from Phillipsburg, where the gems are reported of good blue color, with other tints, and some pale rubies; another is on Cottonwood Creek, 18 miles from Deer Lodge, the stones being of varied colors—red, pink, yellow, and occasionally blue; the third has been recently announced in Choteau County.

As regards the gems themselves, marked differences appear in those from the two principal Montana regions. All are of small size, but the crystallization differs markedly. Those from the Missouri gravels are characterized by the presence of the prismatic faces, with the basal plane, and rarely any of the rhombohedral modifications, the prevailing forms being hexagonal, either prismatic or so short as to be tabular. A beautiful example of this type is figured in Gems and Precious Stones of North America, colored Pl. I, Fig. C. The specimens from the minor localities have generally a similar type of form. The Yogo Gulch

[1] Loc. cit.

crystals, on the other hand, are largely rhombohedral, with the basal plane more or less present, but the prismatic and pyramidal faces hardly at all. The rhombohedral *X*, which is prominent in these crystrals, as shown in figures and descriptions by Mr. J. H. Pratt,[1] has the remarkable interest of being new to this species. Other very noticeable features, which the writer was the first to observe and point out, are the striations on the basal plane parallel to its intersections with the rhombohedron, and sometimes rising into steps as the oscillation becomes a replacement, as well shown in Mr. Pratt's figures, and the singular depressions on the basal plane in other crystals, their sides being formed by faces of the inverse rhombohedron, sometimes meeting in a point and at other times truncated and floored by a basal plane.

We have here two distinct types of crystallization in the same mineral from the same State, and produced apparently under similar conditions in igneous rocks. It will be extremely interesting to learn by further exploitation and study whether these two types bear any fixed or definite relation to the particular variety of eruptive rock in which they occur. The accounts thus far given of the rocks examined seem to suggest such a possibility.

A petrographical description of the Yogo Gulch rock will be given by Prof. L. V. Pirsson, of Yale University, in the American Journal of Science.

He regards the rock as a dark basic lamprophyre, consisting mainly of biotite and pyroxene, having its closest affinities with the monchiquite group, of which he considers it a basic unaltered type. It is much richer in the ferromagnesian components, while lacking the feldspars of the minette group, though it has some relations with them and with the "shonkinites," before described, from this region.[2]

Professor Pirsson regards this occurrence as an important addition to our knowledge concerning pyrogenetic corundums. He holds that the clear-cut forms of the crystals, and also their general distribution, prove them to have been crystallized out of the magma as definitely as the well-formed phenocrysts of feldspar in a porphyry disclose their origin. Their form and occurrence, moreover, agree with the important experiments and conclusions of Lagorio,[3] viz, that corundums originating in an igneous rock form flat hexagonal tables with low rhombohedra, and also correspond to the experiments of Morozcewicz,[4] which showed that molten glass of a basic character dissolves alumina in considerable quantity, and that on cooling crystals of corundum and spinel separate out.

As to the value of the Montana sapphires in jewelry, it is hardly possible yet to predict how far they may be really important. Much beautiful material has already been obtained, but little of high value.

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[1] A paper to appear in Am. Jour. Sci. for September, 1897.
[2] Am. Jour. Sci., 3d series, Vol. L, 1895, p. 467.
[3] Zeitsch. für Krystallographie, Vol. XXIV, 1895, p. 281.
[4] Ibid.

Those from the Missouri bars had a wide range of color—light blue, blue-green, green, and pink—of great delicacy and brilliancy, but not the deep shades of blue and red, that are in demand for fine jewelry. As semiprecious or "fancy" stones, however, they have value.

The Judith River region is more promising, the colors varying from light blue to quite dark blue, including some of the true "cornflower" tint so much prized in the sapphires of Ceylon. Others incline to amethystine and almost ruby shades. Some of them are "peacock blue" and some dichroic, showing a deeper tint in one direction than in another; and some of the "cornflower" gems are equal to any of the Ceylonese, which they strongly resemble, more than they do those of Cashmere. Several thousand carats were taken out in 1895 from a preliminary washing of 100 loads of the "earth." Of these, 200 carats were of gem quality, and yielded, when cut, 60 carats of fine stones, worth from $2 to $15 a carat. All, however, are small, none having yet been obtained of more than 1½ carats in weight.

Mr. T. E. Crutcher, of Helena, Montana, reports that sapphires have been found in some abundance and of good size and quality in the northeastern part of Choteau County, and that a number of claims have been located. The character of the stones found is similar to that of the sapphires from the bars of the Missouri.

Small ruby corundums are reported by Mr. H. H. Rusby, of Gallinas Spring, New Mexico, to have been found in San Miguel County, but no particulars are given as to their quality or mode of occurrence. A single specimen of ruby corundum is mentioned by Mr. E. C. Blackney, of Custer, South Dakota, as having been found near that place. The occurrence of crystals of ruby-red corundum in hornblende slates in the Lower Gem mines, Towns County, Georgia, is reported by Mr. Fereréto S. Ropes, of Franklin, North Carolina.

BURMA.

Over the signature of F. C. Gates, revenue secretary, there were published at Rangoon, Burma, on November 4, 1895, the printed rules concerning the mining for rubies and other precious stones in the Upper Burma ruby district. These are given to the various workers, and treat of the cutting of stones, the buying, selling, and transportation of them, and supplementary rules and lists. Gems are worked for in the north, south, east, and west of the Sangyin region, and during the last five years the work has been carried on more especially in the Mandalay district, which covers about 500 acres.

Dr. Max Bauer, of the University of Marburg, in Hesse, presents an admirable paper on the occurrence of ruby in Burma in the Separat-Abdruck aus dem Neuen Jahrbuch für Mineralogie, Geologie, und Palaeontologie, Jahrg. 1896, vol. 11, pp. 197–238, with one plate. This article exhaustively describes the occurrence of ruby, spinel, and the associated minerals in that country.

BERYL AND EMERALD.

During the past year many fine crystals of beryl of gem value have been found at Topsham, Maine, one a crystal 12 inches long and 2 inches in diameter.

Dr. A. Bibbins, of Baltimore, Maryland, reports transparent beryl found at H. H. Wright's quarry, Hampden, Baltimore County, occurring in pegmatite, with hornblende, associated with almandine garnets. Occasionally one would pass for a gem.

Mr. J. L. Rorison, Bakersville, North Carolina, has found some very good specimens of emerald crystals, quite dark in color on the outer edge, with white or very light interiors, thus resembling the crystals found at Arendal in Norway. Work was carried only to a depth of 6 feet, and nothing of gem value was found, but the specimens were interesting in their resemblance to those from the Norwegian locality.

TOPAZ.

Mr. G. F. Moore, of Roseberry, Boise County, Idaho, who has for some years worked gold-gravel mines about 100 miles north of Boise, has found in the gravel a large waterworn crystal of topaz identical in habit with those from the Alabaschka locality in the Urals. The crystal is of a greenish color, weighs 1,110 carats, and measures 50 millimeters in length and 46 millimeters at its greatest breadth. Associated with it are amethyst crystals, all found on the bed rock. This is the first discovery of topaz reported from Idaho, and the occurrence in the gravel suggests that a locality exists from which this specimen was transported and where perhaps finer material may be found.

An interesting article on topaz and other western minerals by Maynard Bixby appeared in the Mineral Collector for October, 1896, Vol. III, pp. 113–114, with plate. Mr. Bixby calls attention to the remarkable groups of opaque topaz from Thomas Mountain Utah. These are larger than similar transparent crystals, and are definitely terminated, and it is believed that their opacity is due to the occurrence in them of kaolinite crystals. Another locality is described 35 miles southwest from Simpson Springs, Utah, where the largest fine transparent topaz is obtained. The colorless crystals are obtained on the surface, and, as previously noted in this report, fine colored ones are obtained in the matrix at some depth, the colorless variety being evidently originally wine-colored specimens that have been decolorized by exposure to light. Wine-colored topaz crystals have always been known to be sensitive to light, whether they be from the Ural, Japan, New Zealand, Utah, or Mexico. Mr. Bixby also notes a new locality for topaz somewhere near Livingston, Montana, these being of good size and resembling those from Crystal Peak, Colorado.

Topaz has been found in some quantities near Oban, New South Wales; but no particulars have as yet been received, and no important sales reported.

TOURMALINE.

Dr. A. C. Hamlin, of Bangor, Maine, reports the finding of a tourmaline $7\frac{1}{2}$ inches long by 3 inches wide at Mount Mica, Paris, Maine. It was presented to the Garland-Hamlin collection of tourmalines in the mineralogical cabinet of Harvard University.

Mr. A. C. Bates published an interesting article in the Mineral Collector for July, 1896, and describes the tourmaline at Haddam Neck, Connecticut. At this locality a tourmaline crystal has lately been obtained nearly 10 inches in length and an inch in diameter, partially transparent, and of a very rich green color; it is now in the collection of Mr. Clarence S. Bement, of Philadelphia. Many other choice and remarkable specimens have been procured at this locality during the year.

D. C. Morgan & Co., of Waynesville, North Carolina, report crystals of transparent green tourmaline from the vicinity of that place.

CHRYSOLITE.

Mr. W. A. H. Schreiber, Webster, North Carolina, reports olivine (chrysolite, peridot) in granular masses, of a very bright yellow-green color and susceptible of a fine, high polish, from Jackson County, North Carolina. This would be of some interest as an ornamental stone if obtained in any amount.

GARNET.

In California, according to Mr. Braverman, of Visalia, several varieties of garnet occur in Tulare County. He reports essonite (cinnamon garnet) at Three Rivers, pyrope (specimens only, but these to the value of $50) on Rattlesnake Creek, and topazolite near the chrysoprase locality, 12 miles northeast of Visalia. Almandine garnet is reported from South Dakota, on Elephant Gulch, Custer County, as abundant, by Mr. Blackney, of Custer.

QUARTZ.

The crystals of quartz with fluid inclusions from Herkimer County, New York, often contain curiously formed masses of bitumen, moving bubbles of gas, etc. During the past year one of the most interesting of these was found. In a group of three crystals was a cavity in which was a tiny amber-colored spider-shaped inclusion, having small projections of a lustrous black hydrocarbon, evidently of a bituminous nature, the form of the group being exactly that of a spider, which moved freely in the fluid as the crystal was turned.

The extent to which tourist mineral-buying is encouraged is shown in the estimate that 15,000 pounds of crystals of quartz were obtained from Montgomery, Salina, and Garland counties, Arkansas, and sold in the city of Hot Springs for the sum of $5,000, during the year 1896.

Mr. P. McGill, of Cheyenne, Wyoming, states that quartz (rock crystal) is found in considerable quantity about 18 miles west of that place, in Cheyenne Pass. Mr. T. C. Hopkins, State College, Pennsylvania, reports the finding of some very brilliant crystals of quartz, singly and doubly terminated, 2 miles north of White Haven, Luzerne County, Pennsylvania, in seams of red quartzite of the Mauch Chunk red-shale formation. The crystals were quite as clear as those from Herkimer County, New York, and measured from one-half inch in diameter down to microscopic size. Beautiful clusters of small quartz in crystals are announced as occurring at Autauga, Alabama, by Prof. E. A. Smith, of the university of that State. Rock crystal has been found in three localities in Tulare County, California—Drum Valley, Three Rivers, and Yokohol—as reported by Mr. Braverman, of Visalia.

Dr. Bibbins, of Baltimore, reports a crystal of smoky quartz from Harford County, Maryland, 8 inches in length and 3½ inches in diameter, and also the finding of pebbles of smoky quartz in the Potomac gravel derived from the waste of the area of rocks from which crystals are obtained. This fact, of course, indicates the occurrence of the mineral in some quantity. Crystals of 40 pounds each in weight are reported by Mr. R. M. Chatham from the vicinity of Elkin, Surrey County, North Carolina. Large crystals of smoky quartz, 4 to 5 inches in diameter, are obtained at Bandy Creek, Lemhi County, Idaho, as stated by Mr. Cary Wright. The specimens are in the collection of Mr. J. M. Parfets, of Salmon, Idaho. Smoky quartz is mentioned as plentiful by Mr. Blackney, of Custer, South Dakota, but without particulars as to locality. It is also reported in Guadaloupe County, New Mexico, on the Pecos River, by Mr. H. H. Rusby, of Gallinas Spring.

Rose quartz occurs in enormous quantities in the granite region of the Black Hills, according to Mr. Blackney, of Custer, South Dakota; gold quartz is also abundant. It is often rich in color, and has been used to some extent as an ornamental stone. Specimens were brought from there by Dr. Jenney in his first trip to the Black Hills.

Dr. Willis E. Everette, of Tacoma, Washington, has found in that State some very interesting crystals of hyaline quartz, in which there has been a partial alteration, and which, when cut, give peculiar internal reflections.

Rutilated quartz in good specimens is reported from near Glenville, Jackson County, North Carolina, by Mr. Fereretо S. Ropes, of Franklin.

AMETHYST.

Rutilated amethyst crystals from Box Creek, in the Black Hills of South Dakota, are reported by Mr. A. C. Blackney, of Custer. Mr. G. L. Chase, of Colorado Springs, Colorado, reports some beautiful crystals of amethyst from the southern portion of Goochland County, Virginia. Another amethyst locality in the same State is given by

Mr. J. Benjamin Dillon, of Livingston, Nelson County, who announces fine crystals of it near that place.

The return to fashion of the amethyst has done much to encourage the opening of the old locality for the small but dark-purple specimens of this mineral occurring in the Auvergne district, in France, where this industry is now receiving some attention. Many interesting facts have been gathered and recorded by M. Demarty, of Clermont-Ferrand, where the mines are now located. In the Auvergne there are found, in addition to these, ruby, sapphire and zircon (hyacinth variety), beryl (emerald), topaz, resinite opal, agate, jasper, perlite, turquoise, quincite, retinite, spinel, olivine, garnet, and other species of precious and ornamental minerals.

To obtain a grant in France to exploit precious stones it is necessary to be the proprietor of the land. Some 40 hectares are embraced in the amethyst mines (placer), but much of this area is not exploitable, as the amethyst is rarely found limpid and transparent. The mines are situated about 40 kilometers from Clermont, at three principal points, viz, the Ravine, the Fountain, and La Sablonnière (the sand pit). The stone of the vein at the Ravine is about 2.5 meters in thickness. It is not available for jewelry, as it is nearly all opaque and traversed by white zones, but the effect is very agreeable, and it is used for fancy objects, such as jewel boxes, stamp boxes, cane heads, button and glove hooks, etc. The stone is sold in blocks in the rough at $30 for 220 pounds. The working is done in trenches down to 8 meters in depth. In a part of this vein the rock is seamed with agate and chalcedonic opal of a milky blue.

The Fountain is the most important vein, and was exploited about 150 years ago by the Spaniards. A trench has been opened 390 feet in length to a maximum depth of 8.5 meters. The vein is composed of four or five small ones which branch off, then join and unite into one or two more important small veins. The aspect is very irregular, and the thickness varies from 0.01 to 0.9 meter. When the small veins come together they form pockets, where the handsomest stones and the finest crystals are found. The vein does not follow a straight line, but an irregular one, and is strongly inclined. Sometimes the finest stones are at the surface; sometimes it is necessary to search for them at a depth of 20 meters, so that a shaft of 3 by 2.5 meters has been sunk to that level. This shaft is divided, one part being for ladders and one for the lift which brings up the material. The water is taken out by the aid of a suction and flowing pump. Powder is never used, although the gangue (granulite) is often very hard, because powder shatters the rock too much and also blackens it. The stone extracted from the mine is sorted by hand so as to separate the barren portions; and the whole is washed in running water by two women. Then it is carted to a room for rough hewing and trimming, where a woman, by means of a machine, breaks the stone into pieces of variable size, making the choosing and sorting easier. The stone is then passed to another room, where two women, with the aid of steel hammers, separate the good parts from the poor. The stones thus sorted have the size of 0.005 meter to 2 or 3 centimeters, rarely 4 centimeters. They are then sent to Clermont, where two skilled workmen, with the aid of a special reflecting apparatus, choose the stones which can be cut and reject the others. The fine-colored pieces, perfectly transparent, are sold according to their size, from 120 to 800 francs per kilogram. The imperfect stones are used for the manufacture of beads for rosaries, and are worth from 20 to 30 francs per kilogram, according to size. The mine produces weekly about 2 kilograms of first quality and good size; 2 kilograms first quality, smaller; and 4 kilograms second quality. There remain 8 to 10 kilograms of the imperfect stones, from which can be picked out 2 or 3 kilograms for rosary beads. At present 6 miners are employed in the extraction; 2 women for washing; 1 cart driver, for transporting the stones from the mine to the sorting-room; 1 woman for trimming and 5 for sorting; 2 lapidaries at Clermont for choosing the stones and 1 to select the stones; in all, 10 men and 8 women. The cutting is done in the French Jura and in Germany. There has been constructed at Clermont a lapidary's workshop, and in the future the cutting of the amethysts of Auvergne, and of perlites, zircons, hyacinths, sapphires, and resinite opals, all of them Auvergne stones, will be done at this place.

At the Sablonnière vein some exploration has been done, but the vein has not yet been worked, as it does not seem to be very good. The land, the material, the plant, and the outlay necessary for this extensive mining for amethysts represent a capital of 250,000 francs. The production is good and the sale easy, as the amethysts of Auvergne are again coming into fashion, and many have been imported into the United States, frequently selling under the name of Siberian amethyst.

CHRYSOPRASE.

Mr. M. Braverman, of Visalia, California, sends some further accounts of the chrysoprase locality near that place, described in the report for last year, page 913. He estimates the amount taken out during 1896 at $400, more than half of it for cutting, the rest for specimens. Another locality has been opened quite recently on Deer Creek in the southeastern part of Tulare County. Up to the time of Mr. Braverman's report all that had been obtained was pale in color, but the parties were working in the hope of finding better material farther down. Of the two other localities in the same county, mentioned in the last report, nothing further is stated.

AGATE.

Mr. P. McGill, of Cheyenne, Wyoming, reports several localities of agate minerals in that part of the State, viz: moss agate on Reshaw Creek, 50 miles northwest from Cheyenne; rainbow agate from Wolf

Creek and Fox Creek, 45 miles southwest; and jasper bloodstone (heliotrope) in large quantities from the Chugwater, 50 miles northwest from Cheyenne.

Moss agate has been found at Soldiers' Delight, Baltimore County, Maryland, by Miss Eleanor Goucher, daughter of the president of the Woman's College of Baltimore.

The name enhydros, or hydrolite, is given to certain chalcedonic concretions containing a fluid, usually water. These are in fact agates in an incomplete or interrupted stage of formation. Prof. Henry A. Ward, of Rochester, New York, has lately found some remarkable examples of them in Afghan Border, India, quite as fine as those from Uruguay.

The name "cyclops" has been given to a peculiar occurrence of red and white chalcedony in concentric layers, specimens of which, sent from Chihuahua, Mexico, have been cut and polished and placed upon the market as a new semiprecious stone. The specimens for the most part are small nodules, averaging perhaps half an inch across, and are more or less hemispherical. The center consists of a little nodule of red chalcedony, and this is overlain and surrounded by clear or translucent colorless chalcedony. When the convex surface is polished en cabochon the red center shows very strikingly, producing an eye-like effect; and the stones make attractive rings, scarf pins, and the like. They were first sent to Mr. E. J. Smith, of Chicago, who proposed for them the name "cyclops."

OPAL.

Opal mining is assuming considerable importance in New South Wales, especially in the Wilcannia district. The locality, occurrence, and prospects are treated of in the annual report of the department of mines and agriculture, New South Wales, issued in 1895. The chief point is the small mining town of White Cliffs, 62 miles from Wilcannia and 16 miles from the nearest railway station. About 300 men are steadily employed in opal mining at this place. The rock is Cretaceous, and carries seams or veins of common opal, in which occur patches of fine gem material. These are claimed to improve in quality and frequency with increasing depth. The opal seams appear to run somewhat in layers, one of the shafts showing three distinct levels at 10, 20, and 30 feet. Work has been carried down to 50 feet, which is much deeper than any previous level. At that depth there is no sign of change in the opaliferous rock, and therefore the extent to which the gems may occur is still unknown. Some of the material is unsurpassed in quality, though it varies much, the price ranging from $2.50 to $10.50 per ounce, with an average of perhaps $5 at the mines for the fine material. One stone, obtained in 1895, brought $500, and two "patches" were found that yielded $6,000 and $15,000, respectively. In some cases the opal replaces fossil wood and shells. Estimates of the total yield are difficult, owing to the loose and careless manner in which the miners keep their accounts, but enough could be traced to show that the opals sold at the mines had yielded at least $30,000 in 1895, and probably much more, and in three years fully $135,000. The total output since the field began to be worked may reach $500,000. A large area of neighboring country is still unexplored as to the occurrence of opal, and Mr. W. H. J. Slee, chief inspector of mines, is disposed to think that there may be a wide extension of the gem-bearing district. Years ago he obtained specimens of opal, occurring with gypsum, from Milparinka, a point 160 miles from White Cliffs, and he now believes that it may be found at many points between those places and Wilcannia and the Queensland border. Should this prove to be the case, it will be highly interesting to trace the relation of these opal fields to those already exploited in Queensland, described in the report for last year.

A remarkable opal was brought to the United States in 1896 from Australia, which is of interesting origin. It was originally a section of an opalized tree, no trace of the beautiful color being visible except at the broken ends. This, by careful cutting, afforded an opal of 271 carats, in many respects the largest fine opal in the United States, and although of a vegetable origin the cellular structure has been replaced so that not a trace of the original woody structure is visible.

Dr. Bibbins, of Baltimore, reports a brown and milky opal, with hyalite, from Bare Hills, Maryland, found by Dr. A. C. Spencer.

Mr. Warren M. Foote, of Philadelphia, Pennsylvania, reports opalized wood in magnificent compact masses up to 1 foot in diameter, susceptible of a high polish and showing the replacement in detail of wood cells, fiber, and structure by a lustrous brown and yellow semiopal, from Clover Creek, Lincoln County, Idaho.

TURQUOISE.

The British consul at Meshed has treated exhaustively of the ancient turquoise mines of Persia in an article in the London Times. The great source of the world's supply of turquoise has long been the locality in Khorassan, in northern Persia. Anciently it was obtained in Arabia, and recently the New World has become prominent, Arizona and New Mexico yielding largely. The Persian mines are constantly worked, however, though in a rude oriental fashion; but they are rarely visited, and hence considerable interest attaches to this account from Meshed, the nearest important commercial town.

Nishapur, the name usually given to the locality, is situated about 400 miles due east from Teheran. The mines are a few miles from Nishapur, at an elevation of some 6,000 feet above sea level. Ascending gradually through low hills, with villages where the miners live, the visitor comes to an east-west ridge, with the turquoise mines lying along its southern face for a distance of about half a mile. Only one, known as the Reish mine, is at present actively worked. There is little or no system employed, as the mine is leased with a precarious tenure, and the holders may be thrown out at any time by a higher bidder; their only effort, therefore, is to get as much as possible out of it with the least present cost.

The entrance is a cave-like excavation near the top of the ridge, about 12 yards across, with a vertical shaft of 15 feet in diameter going down some 80 or 90 feet. At the top of this shaft two men recline with their backs against the cave wall, and turn with their feet a wooden wheel, which brings up a sheepskin bag, holding perhaps a peck of débris. This is taken out, emptied, and replaced by a third man, and then sent down by a "run" of the wheel to a point about halfway down the shaft, where two more men, on a ledge, are similarly engaged. At the mouth of the cave a number of men are seated together, breaking up the pieces of rock with small hammers. Whenever a good-sized piece of turquoise is found, it is laid to one side to be sent to Meshed. The finer débris is sifted and picked over by a large number of boys.

The bags come up rapidly and contain much turquoise of various grades. The mine produces large amounts, but a good deal of it is inferior—some greenish, some liable to fade, and some affected with whitish spots. Really fine stones are rare; but the Orientals use the defective material as well, for they all esteem it, and the poorest, if possible, must have some kind of a turquoise, if only a greenish or faded one, set in a tin ring. All the work thus far done, however, reaches very little into the hill; and from the abundance of the gem wherever the rock is opened there must be a great deal of fine material not yet approached. Even before the hill is reached the surface is seen to be strewn with fragments of turquoise in various stages of alteration, from green and flawed pieces to a chalky yellowish mass entirely changed in appearance. On entering the cave one sees that the rock walls are seamed with blue and green streaks of turquoise. But much that looks well when first obtained is liable to fade or turn green. In some cases white specks appear, which gradually enlarge until they destroy the value and beauty of the stone; and at Meshed, where the product is taken to be cut and exported, no one will purchase a turquoise until he has had it in his possession for some days. After cutting at Meshed, they are at once exported, their price rising as much as tenfold at that place, where it is hard to buy fine, perfect stones now, though in former years they could be had there at quite moderate rates. Turquoises are cheaper now in Constantinople, Tiflis, and even in India, than they are in Meshed.

Turquoise has been discovered in Australia at a locality named Mount Lorigan, in New South Wales. Indications are favorable, and considerable work has been done, but no important results are as yet reported.

M. Carnot, in the Bulletin of the Mineralogical Society of France, vol. xviii, 1895, pp. 119–123, gives an analysis of the turquoise from the

Burro Mountains, Arizona, and compares it with an analysis made of the Persian turquoise, as follows:

Analyses of turquoise.

	Phosphoric acid (P_2O_5).	Alumina (Al_2O_3).	Copper oxide (CuO).	Ferrous oxide (FeO).	Lime (CaO).	Water (H_2O).	Quartz or clay.	MnO, MgO, F.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Pr. ct.*	
Burro Mountains	28.29	34.32	7.41	0.91	7.93	18.24	2.73	Trace.
Persia	29.43	42.17	5.10	4.50	....	18.59	.21	Trace.

These results show the Arizona material to differ chiefly in the presence of calcium oxide and the absence of most of the iron. M. Carnot also emphasizes the fact that all the iron in both is in the protoxide state; whereas in the standard analyses heretofore given it has been regarded as mainly sesquioxide. Turquoise analyses present considerable variation; but M. Carnot deduces, as a formula to which they may all be fairly referred—

$$P_2O_5(Al_2O_3,Cu_3,Fe_3,Ca_3)O_3+Al_2O_3+5H_2O.$$

JADEITE.

Prof. Max Bauer, in the Jahrbuch für Mineralogie, 1896, vol. i, p. 85, announces the discovery, based upon specimens of jadeite from an unknown locality in Thibet, that this mineral is a component of a rock consisting of plagioclase, nephelite, and jadeite, the last sometimes preponderating to the exclusion of the other two. He remarks that if the jadeite here is, as usual, a member of the group of crystalline schists, we have in that case the first occurrence of nephelite in other than eruptive rocks.

Prof. L. V. Pirrson, in the American Journal of Science, fourth series, vol. 1, 1896, p. 401, says:

> It appears to us, however, that this interesting occurrence of nephelite may prove to be of great importance in explaining the origin of jadeite, whose significance in the crystalline schists has never been understood, and it may also furnish one explanation why, among all the varieties of metamorphosed igneous rocks occurring among the crystalline schists, those containing nephelite have not been found.

WARDITE.

This is a new mineral that may possess some interest as a semiprecious stone. It was described by Mr. J. M. Davison in the American Journal of Science for August, 1896. It occurs in coatings and concentric layered masses, with an oölitic or spherulitic structure, encrusting cavities in the massive variscite from Utah. Its color is light green, or bluish green; luster, vitreous; hardness, about 5—greater than variscite; and specific gravity, 2.77. In composition it is a hydrous phosphate of alumina, with 6 per cent of soda, a little magnesia and iron, and a trace of copper protoxide. The formula derived comes very close to turquoise; but the presence of the soda and the comparative absence of copper are marked distinctions. It seems to form a third member of a group in which peganite and turquoise precede it—phosphates of alumina in which the water increases regularly. The species was named in honor of Prof. Henry A. Ward, of Rochester, New York.

SMITHSONITE.

Golden-yellow carbonate of zinc, locally known as "Turkey fat," occurs in beautiful mammillary masses in the Morning Star mine, Yellville, Arkansas. The coloring matter of this is undoubtedly greenockite (sulphide of cadmium). These, when cut and polished, form very pleasing ornamental stones. The coloring is richer than in any of the smithsonite found at the ancient zinc mines of Laurium, in Greece, which have been worked for two thousand years. Some fine examples of this mineral are now in the cabinet of the United States National Museum and in the Field Columbian Museum at Chicago. These were found by Mr. W. A. Chapman, of Yellville, Arkansas, and were cut by Prof. F. W. Clarke, of the United States Geological Survey.

AMBER.

A remarkable article on the fossilized woods of the United States, by Prof. F. H. Knowlton, of the United States Geological Survey appeared in Science for April 17, 1897, new series, Vol. III, p. 582. He treats largely of the occurrence and geology of the amber deposits of Cape Sable, Maryland; of those near Canyon Diablo, Arizona; in the vicinity of the Black Hills, South Dakota; at Trenton and Camden, New Jersey; and in Chesapeake and Delaware counties, Maryland. He also traces the amber in the Magothy River district, Maryland, to a tree, the cell structure of which he has studied, and which he has named, for the present, *Cupressinoxylon bibbinsi.*

A paper of much interest, on amber, appeared during the past year in the form of an address delivered at the Ipswich meeting of the British Association for the Advancement of Science, by Dr. Conwentz, curator of the Provincial Natural History Museum at Dantzic, and perhaps the greatest living authority upon amber. This address, although dealing generally with the amber of the Baltic and of northern Europe, had special reference to that found on the east coast of England. After distinguishing the three species of fossil resin associated under the name of amber—the soft varities termed *gedanite* and *glessite*, and the harder *succinite*, or amber proper—Dr. Conwentz presents the facts, gathered at many points, as to the occasional occurrence of succinite on the British coast, and fixes its limits. It is found more or less in Norfolk and Suffolk, extending southward to Essex and northward to

Yorkshire, chiefly cast up on the shore or brought in by fishermen's nets. Quite a little local industry exists at some points in cutting and polishing it into charms and ornaments. These are also now imported from Prussia, and sold to visitors sometimes as local material; but Dr. Conwentz is satisfied that most of it is truly English. The interesting deduction is made that the prehistoric amber articles found in graves, etc., in England, dating back even to the stone age, are probably of native material, and not derived from the Continent, as has been generally supposed. They are not abundant; and the amber known to be now obtained along the British coast would account for all the ancient objects without the necessity of inferring a foreign source.

As to the general occurrence of amber, the source is a bed of clay and green sand, in which it occurs with fossil wood, etc., partly in Smaland and partly under the Baltic, and from which it is washed out and cast up on the shores not only of Prussia, but of Denmark, southern Finland, and several of the Baltic islands. Then it is found at points on the coast of Holland and England, indicating a wide extension of the Smaland bed, to some extent at least under the present German Ocean. The age of this bed is Lower Oligocene, and the age of the amber itself and of the trees that produced it is thus carried back to the later Eocene. Dr. Conwentz discusses the nature of the associated wood, and finds no difference in its microscopic structure from that of modern pines, so that the separate genus Pinites is not warranted, and the amber pine should be known as *Pinus succinifera*. Probably, however, other coniferous trees shared in the production, especially of the associated glessite and gedanite, and leaves and flowers of several such species are preserved in pieces of amber. In addition, many traces of other groups of plants are similarly inclosed, some of which are of great interest, as indicating the presence in northern Europe of a number of genera and families related to the present flora of Asia and North America, and showing a warm temperate climate. This conclusion is not new, but the facts as presented in Dr. Conwentz's paper are of great geological interest in confirming it.

USE OF GEMS.

The use of jewels for ecclesiastical purposes is growing more frequent. The most remarkable article of the kind in this country was presented during the past year to Trinity Church, New York, by Prof. Thomas Egleston, founder of the School of Mines, Columbia University, who has for many years been a vestryman of that church. A peculiar interest attaches to this object in several ways. It is in itself a collection of elegant stones, many of them of rare varieties, obtained during years of travel with exceptional opportunities. Professor Egleston collected them and gave them to his wife, who died in 1895; and they have now, with their settings, been made into this very beautiful and striking memorial gift—a jeweled communion chalice in memory of Mrs. Augusta McVickar Egleston, the design being Professor Egleston's.

The chalice is 9 inches high and half that width. It rises from a cup embossed with fleur-de-lis crosses, set with rich purple Ural amethysts and Indian carbuncles. The highly ornamented stem that supports this has three blue sapphires, two yellow diamonds, and a ruby-red Nevada garnet set into it, while the top of the base bears six Ceylonese chrysoberyls and a green tourmaline from Maine. Below, the sides of the base form six vertical panels; three of these bear repoussé designs in gold—of the Crucifixion, the Adoration, and the Baptism of Christ, respectively—separated by three floriated panels, two of passion flowers and one of a jeweled cross. All these are set with beautiful gems; the passion flowers in one of the panels have an emerald for the center of each, in the other a sapphire; the cross consists of five stones, the one at the intersection being a yellow sapphire; the left arm, a red zircon; the right, a moldavite (the rare green volcanic glass of Moravia); above is a green sapphire ("Oriental emerald"), and below a green zircon and an andalusite. At the top of the panel is a star ruby (asteria), and at the bottom a Brazilian topaz. At the foot of the cross are two garnets, one from Nevada, ruby-red, the other a green demantoid ("Uralian emerald") from the Ural Mountains; around it, in the four spaces, are four rubellites.

This description may give an idea of the richness and rarity of the gems in this unique object. All the panels and the foot of the chalice are similarly inlaid, the latter with six Ceylonese moonstones alternating with Siriam carbuncles, and between these twelve green garnets. In all there are 180 stones, and the list of species includes amethyst, andalusite, chlorastrolite, chrysoberyl, diamond, emerald, garnet, moldavite, moonstone, peridot, ruby, sapphire, tourmaline, topaz, and zircon, and many of these in rare shades of color.

Among the most novel aspects of fashion in reference to diamonds, mention may be made of two points: the interest taken in colored diamonds, and the engraving of initials, monograms, etc., on the faces of table diamonds. In regard to the former, the increasing abundance of white stones is leading to a demand for the much rarer colored ones among those who purchase objects of elegant luxury without regard to cost. The remarkable Egleston memorial chalice, just described, has among its rich jewel decorations a number of colored diamonds. The De Beers Company has in its office at Kimberley a case containing perhaps a dozen diamonds of peculiar elegance and value, several of which are colored. Some are deep blue, and one of considerable size is a flawless stone of deep rose color, believed to be the finest pink diamond known. It can not be purchased.

The engraving of diamonds, though by no means new, is coming into vogue somewhat again; and work of the kind is announced as done by some jewelers in this country, for the first time. Mary Queen of Scots is said to have possessed a large diamond engraved with her coat of arms, which is now owned by a private collector in England. A fine specimen is also in the Tiffany collection at the Field Columbian Museum at Chicago. This is a large stone on which is carved a likeness of William II of Holland. The work is said to have occupied the artist, Devrees, for five years. At the late Antwerp Exposition was shown a finger ring and a cross, each cut out of a single piece of diamond. The process is conducted by means of a very small revolving drill, similar in its action to the dentist's drill, making 3,000 to 10,000 revolutions per minute. It is manipulated with the fingers, like a pencil, the operator dipping the tip from time to time into a mixture of oil and diamond dust. Of course, the work is extremely slow, and requires the utmost patience and skill. It necessarily spoils the brilliancy of the stone, by interfering with the reflection and refraction of light that give the diamond its chief beauty, and must be regarded rather as a tour de force than as a branch of really ornamental art.

At no time in the past decade has there been such a large demand as there is at present for the colored precious stones of all varieties, including emeralds, rubies, and sapphires, fine examples of which have commanded prices never before equaled. The lesser gems, such as topaz, a Spanish variety of quartz, amethyst, and many others, have been used for purse tops, cardcases, and even ornaments for silver-mounted cut glass, etc., so that the demand has nearly equaled the supply; and not only jewelers but silversmiths have been using the colored gems in great quantities.

The prolific occurrence of beautiful opal in Queensland and New South Wales, and the great ingenuity displayed in the jeweler's art, have led to a number of peculiar forms of cutting. First, in the form of round beads that are drilled, producing the effect of pearls with an iridescent play of colors; frequently there is strung between the beads a roundelle-cut diamond, emerald, amethyst, or topaz, the rondelle being a flat bead with faceted edges. Another form of cutting is one in which the opal bead is cut in two, forming hemispheres, and between the two halves there is set a diamond, emerald, topaz, or rock-crystal rondelle, the whole forming a perfect bead, the brilliant-cut transparent gem of whatever color, in the center, furnishing a wonderfully pleasing effect to this otherwise crystallized rainbow.

GEM LITERATURE.

An interesting article on precious stones has appeared in the volume issued by T. K. Brunner, secretary of the State Board of Agriculture, Raleigh, North Carolina, entitled North Carolina and its Resources, 1896, pp. 107–113, the article being illustrated with colored plates of nine specimens and numerous illustrations of North Carolina gem minerals. The report is very clear, and as it contains a full description of the minerals of the State, it can not fail to be a valuable aid to geologists and naturalists, as well as to investors.

Prof. F. W. Rudler, of the Royal School of Mines, London, has prepared a new edition of the Handbook to the Museum of Practical Geology, Jermyn street, London, which has been issued in 8vo, viii, 167 pp., and is sold by the museum only. This is the guide and descriptive catalogue of one of the most comprehensive and admirably displayed museums in Europe. There are many references to precious stones (pp. 101–119), and in the museum itself there are beautiful and characteristic, and often unique, examples. The collection, being so central in the world's greatest metropolis, does much to create a taste for precious stones and to serve as a reference collection to all who visit it from all quarters of the globe.

In the report of the United States National Museum for 1894, pp. 633–750, an admirable article appears on the study of primitive methods of drilling, by Mr. J. D. McGuire. In this report Mr. McGuire treats exhaustively of the primitive methods of chipping, drilling, and engraving, from the earliest times to our own day, giving various forms of aboriginal drills from ancient Egypt to the present, and throwing much light on the subject of prehistoric and savage stone cutting.

In the Alphabetical Dictionary of Names of Minerals; Their History and Etymology, by Prof. Albert H. Chester, New York, 1896, 8vo, 320 pp., Wiley and Son, there are given about 5,000 names of minerals and gems, with the references to the original authorities. This is a great convenience as a check list to all interested in minerals and precious stones.

Artificial minerals are scarcely within the province of this report. Carborundum is a mineral that has never existed in nature, but for an abrasive its only peer is the diamond. It has been formed in large quantities in magnificent crystals, which, although not transparent, are highly polished, and as a crystallized brilliant product are quite equal in elegance to any mineral found. These are now made on an immense scale by the Carborundum Company at their works at Niagara Falls, the motive power of which is electricity generated by Niagara water power.

PRODUCTION IN THE UNITED STATES.

Production of precious stones in the United States in 1896.

Diamond	None.
Sapphire	$10,000
Ruby	1,000
Topaz	200
Beryl (aquamarine, etc.)	700
Emerald	None.
Phenacite	None.
Tourmaline	3,000
Peridot	500
Quartz, crystal	7,000
Smoky quartz	2,500
Rose quartz	500
Amethyst	500
Prase	100
Gold quartz	10,000
Rutilated quartz	500
Dumortierite in quartz	50
Agate	1,000
Moss agate	1,000
Chrysoprase	600
Silicified wood	4,000
Opal	200
Garnet (almandite)	500
Garnet (pyrope)	2,000
Topazolite	100
Amazon stone	1,000
Oligoclase	500
Moonstone	250
Turquoise	40,000
Utahlite (compact variscite)	500
Chlorastrolite	500
Thomsonite	500
Prehnite	100
Diopside	200
Epidote	250
Pyrite	1,000
Rutile	100
Anthracite	2,000
Catlinite (pipestone)	3,000
Fossil coral	1,000
Arrow points	1,000
Total	97,850