DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

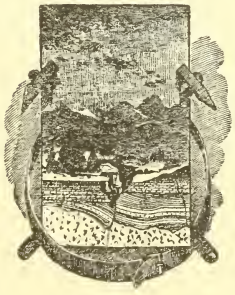
MINERAL RESOURCES

OF THE

UNITED STATES

CALENDAR YEAR
1905

DAVID T. DAY
CHIEF OF DIVISION OF MINING AND MINERAL RESOURCES



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PRECIOUS STONES.

By George Frederick Kunz.

INTRODUCTION.

The year 1905 made a record for the importation of precious stones of every variety. This importation was attended by prosperity in every branch of the jewelry business, the sales ranging from the richest gems to those of the poorest qualities, and even to every known form of imitation. This record was achieved notwithstanding the Russo-Japanese war, and was due to general prosperity.

The discovery of utahlite, a green variscite, translucent, golden-green in color, and used as a gem and decorative stone, at a new locality 40 miles southwest from Salt Lake City, 8 or 9 miles west of Stockton, 20 miles northwest of Mercur, and 25 miles northwest of the other utahlite locality in Utah, promises to furnish a quantity of this peculiarly American stone that may be used in semibarbaric jewelry or where a rich but not precious stone is desired.

In the search for and the mining of tourmaline, beryl, topaz, kunzite, and other stones peculiar to the southern counties of California, some wonderful crystals of rose-colored beryl implanted on feldspar and many fine crystals of tourmaline (red and green) are found, and in connection with these occur many specimens of great interest to the science of mineralogy. The region bids fair to excel that of the Ural Mountains, which for more than half a century has led the world in such products. So great has been the interest in California gems and their mining that the State mineralogist, the Hon. Lewis E. Aubury, requested the writer to prepare an illustrated report on the finding, the history, and the cutting of the precious stones of California, with a description of its mines. This volume, numbering 150 pages, illustrated with many plates, is now being issued by the California Bureau of Mines in San Francisco.

In the State of Maine, during 1905, prospecting and slight working was done for gems at Mount Mica, Paris, Auburn, Newry, Mount Black, Rumford, and other mining localities. But only a few gems, tourmalines, were found, and their total value did not exceed a few thousand dollars.

The turquoise mines of New Mexico and Arizona have not been as productive as formerly, but those of California and Nevada have been more so.

Rose quartz from the Black Hills of South Dakota has been cut in great quantity in the form of beads, in Germany, and has been sold over the entire world in competition with rich green aventurine with its sparkling specks of mica.

Amethyst, topaz, malachite, lapis lazuli, amazon stone from Amelia County, Va., and a great variety of stones of all quaint colors have been in greater demand than in 1904. The topaz sold is generally the variety known as "Saxon" or "Spanish" topaz. It is in reality the result of the decolorization

of the smoky quartz found in Spain, Brazil, and Colorado, and according to the amount of unexpelled color, it is straw-colored, amber-yellow, or rich reddish-brown. So much demand has existed for the true Brazilian yellow topaz and the pink topaz, the latter produced by heating the Brazilian yellow, that the opening of the original mines at Ouro Preto in Brazil is under discussion.

A novelty in the gem line has been the cutting of the chrysoprase, so extensively found at Visalia, Tulare County, Cal., in its iron-brown and dark-brown matrix, which forms a pleasing contrast to the golden-green color of the chrysoprase.

Highly colored gems, green, red, yellow, and purple, have been in great demand, so much so that many thousands of peridots of Arizona origin have been cut, and many times more of those from Egypt. This is equally true of the California tourmalines, pink and red, and also of those from the Urals and from Madagascar and Brazil. So great has been the demand for amethyst that the remainder of the great finds in Brazil, in 1900, and also stones from every available source have been cut, frequently into pear-shaped and diamond-shaped stones.

The emerald is still the gem in evidence. At no time has it received so high appreciation as to price. It is more than ever in demand, for the supply has been only in part sustained by the yield of the mines in the United States of Colombia. Part of the gems have been cut in the United States from the rough stones shipped directly to the firms doing the cutting. Many of the finest gems were undoubtedly taken from old jewels by the owners on the inducement of the high prices obtained.

The pearl is in as great favor as ever. The English Government has published the results of the investigations of the experts who have studied the life history of the pearl oyster, its parasites, its enemies, and the methods of further increasing its production. The present demand is causing a drain upon the Ceylon pearl banks, which have always yielded so great a revenue.

Within the last two years, and with the introduction of Louis XV and Louis XVI designs in jewelry, there has been immense improvement in lapidary work in the United States in every variety of stone. No better lapidary work has ever been done at any period, and every intricate form of cutting and polishing such gems as aquamarines, tourmalines, peridots, kunzite, amethyst, and similar stones has been employed, including not only the round but the oblong, hexagonal, octagonal, marquise, pear-shaped, and other forms set with borders of small brilliants. There has been especial preference for many of the larger stones; and never have aquamarines, tourmalines, and amethysts been sold in such profusion. Probably $100,000 worth of aquamarines from the Brazilian locality found two years ago have been used.

DIAMOND.

UNITED STATES.

There are four regions where diamonds have been met with in the United States. These are (1) the Pacific coast, chiefly along the western base of the Sierra Nevada, in the central counties of California, associated with gold in the cement gravels; (2) along the line of the moraine of the ancient ice sheet in Wisconsin, Michigan, Indiana, and Ohio; these have been transported from an undiscovered source, presumably somewhere in Canada; (3) Kentucky and Tennessee; (4) the Atlantic States from Virginia to Alabama, chiefly along the eastern base of the Appalachians in what is known as the Piedmont region. The actual place of origin of the diamonds is in all these cases unknown. Those

of the Pacific coast and the Atlantic States have been derived by erosion from the adjacent mountain ranges, but the original sources have never been discovered. Those of the northern drift have doubtless come from beyond our borders, in Dominion territory, and their exact source is entirely a matter of speculation. The few occurrences in Tennessee and Kentucky are not as yet definitely traceable, even in theory. All have been found in loose and superficial deposits, and all accidentally. Most of those in the Atlantic and Pacific regions have been met with in washing for gold.

This subject of the occurrence of diamonds in the United States has been treated in some detail by the writer in a report to the United States Geological Survey, to be issued in the near future.

SEARCH FOR DIAMONDS IN BLACK SANDS OF THE UNITED STATES.

The high price of diamonds has made the search for these precious stones in the United States and Canada keener than ever before. In the examination by the United States Geological Survey of many samples of gold and platinum sands during the Lewis and Clark Exposition at Portland, Oreg., diamonds were carefully looked for. Diamonds have been watched for also by a number of parties that have been dredging for gold on an extensive scale in the rivers of California, but in neither case have any finds been reported.

INDIANA.

Minerals of the Indiana drift in relation to their supposed Canadian source.— The only well-attested diamond discoveries in the drift region of the United States during the last four years have been those in connection with the gold washings of Brown and Morgan counties, in southern central Indiana. The writer has taken special pains to obtain a full series of specimens of the rocks and minerals found in the gold-bearing drift of this region from Mr. George C. Royce, of Martinsburg, W. Va., and Professor Blatchley, State geologist of Indiana, and others, for the purpose of having them compared with the rocks in Canada, north of the Great Lakes, with a view to tracing out, if possible, the source whence the diamonds came.

With the hope of aiding in the solution of this problem the collections of drift minerals and rocks from the diamond section of Indiana were sent to Canada for examination and were laid before the Ottawa meeting of the Geological Society of America in December, 1905. Considerable discussion was awakened, but no very definite results have as yet been reached.

Among those who examined the specimens at the meeting with particular interest and expressed opinions thereon are the following Canadian geologists: Dr. A. E. Barlow, Mr. W. J. Wilson, and Prof. H. M. Ami, of the geological survey of Canada; Prof. W. G. Miller, of the Ontario Bureau of Mines; Dr. G. A. Young, petrographer, and subsequently in more detail, Prof. Frank D. Adams, of McGill University, at Montreal. All these gentlemen were especially qualified to judge of these materials by intimate acquaintance with the geology of the region under consideration and its glacial phenomena.

Doctor Barlow and Mr. Wilson recognized a number of the fragments in the collection from the Indiana drift as apparently identical with rocks familiar to them at various points in northern Ontario. Especially marked was the prevalence of pieces and rolled pebbles of jasper and jaspilite, characteristic in association with the iron ores of the Michipicoten and other iron ranges north of Lake Superior.

After the meeting of the geological society the material, consisting of some 30 samples, was sent to Prof. F. D. Adams, of McGill University, for more detailed examination. In these 30 samples there were more than 200 specimens, every one of which was carefully examined by Professor Adams, who then divided them into groups clearly definable. These groups and the percentages which they represent he states as follows:

1. Laurentian gneiss	14.4
2. Quartzite	29.8
3. Chert and jasper	32.7
4. Iron ore	9.6
5. Amphibolite and green schist	6.3
6. Trap, two types	.8
7. Sandstone, etc.	4.0
8. Limestone and shale	2.4
	100.0

No. 1 is represented by characteristic material, much of it evidently coarse pegmatite, rich in feldspar.

Nos. 3 and 4 are certainly, and Nos. 5 and 6 probably, from the iron ranges of the Huronian or Keewatin.

The pieces numbered 7 seem to be partly Keewenawan and partly Huronian, while those included under 8 are distinctly Paleozoic.

It thus appears that the portions decidedly referable to the iron ranges of the Huronian and Keewatin (Nos. 3 to 6, inclusive) make up nearly half of the whole material (49.4 per cent), while the quartzite, No. 2 (29.8 per cent), is largely Huronian. These rocks are widely developed north of the Great Lakes and at no great distance from them.

KENTUCKY.

There has been some revival of speculation as to the existence of diamonds in the peridotite dikes of northeastern Kentucky. Mr. D. Draper, a Transvaal geologist, has visited the celebrated dike at Ison Creek, in Elliott County. The lessees or owners have under consideration a plan to work a large part of this tract with diamond machinery like that used at the South African mines, and apparently this entire tract of land has been bonded and the parties engaged are endeavoring to proceed to work the place extensively, although up to the present time no definite proof exists of the occurrence of diamonds in this region. The examination made there by the Kentucky Geological Survey, under the late Prof. John A. Procter and Doctor Crandall, and also that made by Mr. J. S. Diller and the writer seventeen years ago, were both without result. Recently Mr. W. C. Phalen, of the United States Geological Survey, visited the region and spent some time in the preparation of an economic bulletin on the Kenova quadrangle. He located a new outcrop of the peridotite, but was unsuccessful in obtaining any diamonds. He heard at Grayson, Carter County, that a diamond or two had been found in the Ison Creek district, but he could not verify the report.

NEW YORK.

Diamonds in drift.—In the article of Prof. William H. Hobbs, on "The Diamond Field of the Great Lakes," published in 1899,[a] emphasis was laid on the

[a] Jour. Geol., vol. 7, No. 4, May-June, 1899.

desirability of careful search for diamond occurrences on the moraine line east of Ohio—in Pennsylvania and New York—as a further guide to locating the original northern starting point. No similar discoveries have since been made, except those in central Indiana, until recently a report has appeared of one or perhaps two diamonds being found near Syracuse, N. Y. An account of these and a discussion of the bearings of the whole subject were given by Mr. Philip F. Schneider, of that city, in the Syracuse Herald[a] of December 24, 1905. The topic had been presented previously, by Mr. Schneider and others, at the October meeting of the Onondaga Academy of Sciences. Unfortunately the facts are not capable of positive proof at the present time. The owner of the gravel-pit in the southern part of Syracuse claims to have found a diamond therein several years ago and to have subsequently sold it for $1,700 to a person living at Springfield, Mass. The purchaser has since died, and his relatives are in Europe, so that it is not possible at present to verify the account. The same owner also reports finding another smaller diamond, which he still retains; but Mr. Schneider questions its reality, and suspects it to be only a quartz crystal.

The geological interest of such an occurrence and its inherent probability in connection with the western diamonds of the drift make these unverified reports worth recording.

In Mr. Schneider's article he also treats of the possible relation of these diamonds, if such they should prove to be, with the peridotite dikes in and around Syracuse. It will be remembered that this rock, altered to serpentine, was identified by the late Prof. H. Carvill Lewis with the rock at Kimberley, South Africa, and with that in Elliott County, Ky., all three being included under his name of kimberlite.

This close relationship to the South African diamond-bearing rock has led to speculation and may lead to possible diamond production at the Kentucky and the Syracuse localitites, especially as both these latter have yielded pyrope garnets similar to those freely obtained at Kimberley, and there known as "Cape rubies." No diamonds, however, have been definitely found as yet at either of the American kimberlite occurrences; but if any should really be obtained near Syracuse, the question may be raised whether they are derived from the drift or from the kimberlite dikes of the vicinity.

CANADA.

Search for diamonds.—Dr. H. M. Ami, of the geological survey of Canada, has given careful instructions to a hundred or more parties that are surveying for the Transcontinental Railroad, immediately north of the Great Lake region, how to look for the diamonds in the hope of their locating the source of the diamonds which have been found in the glacial deposits of Wisconsin, Michigan, Ohio, and Indiana.

SOUTH AFRICA.

De Beers Consolidated mines.—The most prominent feature in the seventeenth annual report of the De Beers Consolidated mines, for the year ending June 30, 1905, laid before the meeting of the shareholders at Kimberley, in November, is doubtless the retirement of Mr. Gardner F. Williams from the office of general manager, which position he has held and administered with signal ability and

[a] Syracuse Herald, December 24, 1905.

success for the last nineteen years. He has for some time desired to be relieved from the cares of this position, and he will now be succeeded by his son, Mr. Alpheus F. Williams, who has been assistant manager for several years, is thoroughly familiar with the situation, and has ably conducted the working of this great mine in the several absences of his father in the United States.

In regard to the output of the year, it presents no very marked differences from that of the year 1904. There is some advance in total production, due to the increasing yield of the two newer mines, the Bultfontein and the Dutoitspan; but the old mines show a continued falling off. On the other hand, the Bultfontein and Dutoitspan have developed a sudden advance in richness, the yield per load of these two mines taken together being some 40 per cent above that of the year before. The other mine, previously known both as the Premier and the Wesselton, remains about the same in rate of production. This mine is spoken of in the present report only as the Wesselton, the name Premier being apparently discarded, and wisely so, in view of the prominence assumed by the great Premier mine near Pretoria in the Transvaal.

The combined data for the De Beers and Kimberley mines are as follows:

Production of De Beers and Kimberley mines in 1904 and 1905.

	1904.	1905.
Loads of blue hoisted	2,440,895	2,447,850
Loads of blue washed	2,401,099	2,418,158
Carats of diamonds found[a]	1,303,525	1,108,980
Value of diamonds found[a]	£3,192,798	£2,929,589
Number of carats per load	0.54	0.46
Value per carat[a]	48s. 11d.	52s. 10d.
Value per load[a]	26s. 7d.	24s. 3d.
Cost of production per load[a]	7s. 4d.	7s. 8d.
Loads remaining on floors	2,175,079	2,204,771

[a] Fractions omitted or approximated.

It will be seen from these figures that the continued rise in value has again failed to counteract the decrease in richness, as shown by the diminished value per load. The quantity of blue ground reported as in sight in 1904 in these two mines was 9,987,908 loads; in 1905 it was 8,026,400 loads—a decrease of about one-fifth.

Of the three newer mines the Wesselton furnished the maximum quantity of blue ground, 2,068,278 loads; and it yielded also one diamond of 187½ carats, the largest yet found in this mine. The Bultfontein leaped from a yield of 0.29 carat per load in 1904 to an average of 0.41 in 1905. This yield rose further during the latter half of the year, and a test from the east end of the mine area gave, in 32,122 loads, an average as high as 0.523 carat. The Dutoitspan mine more than doubled its former average yield, having risen from 0.12 to 0.26 carat per load. In quality the diamonds from this mine are far above those from any other. All three are still worked more or less as open mines.

The data for these mines for the last two years are as follows:

Production of the Wesselton, Bultfontein, and Dutoitspan mines in 1904 and 1905.

	Wesselton.		Bultfontein.		Dutoitspan.	
	1904.	1905.	1904.	1905.	1904.	1905.
Loads hoisted	1,919,304	2,068,278	429,729	605,730	39,914	311,499
Loads washed	2,134,903	2,032,582	514,385	611,491	24,359	65,784
Diamonds found (carats)[a]	605,241	578,152	148,219	249,002	3,032	17,121
Value of same[a]	£1,055,269	£1,067,475	£219,711	£434,902	£6,457	£59,847
Carats per load	0.28	0.284	0.29	0.41	0.12	0.26
Value per carat[a]	34s. 10d.	36s. 11d.	29s. 7d.	34s. 11d.	(*b*)	69s. 11d.
Value per load[a]	9s. 10d.	10s. 6d.	8s. 6d.	14s. 2d.	(*b*)	18s. 2d.
Cost per load[a]	3s. 7d.	3s. 10d.	5s. 9d.	5s. 10d.	(*b*)	12s. 3d.
Loads on floors	1,356,260	1,391,956	397,503	391,742	15,555	261,270

[a] Fractions of pounds, carats, and pence omitted or approximated. [b] Data not given.

The quantity of blue ground in sight at these mines was estimated as amounting to 51,300,300 loads. This amount being added to that given above for the De Beers and Kimberley—8,026,400—the entire total foots up 59,326,700 loads. Beyond this, however, there are of course the unexplored resources of the three newer mines which have only been opened to depths from one-fourth to one-third those of the older mines.

The recovery of diamonds from tailings and débris has continued, though on a scale somewhat less than in the previous year, which was the maximum. In 1905 1,616,030 loads were washed, mostly from the De Beers mine, and there were obtained 257,059 carats of stones, valued at £311,030.

Even with the higher rate realized for rough diamonds, the earnings of the De Beers Company were 15 per cent less than in 1903, as the average yield of rough diamonds from the De Beers and Kimberley mines has fallen from 0.76 carat per load in 1902 to 0.61 carat per load in 1903 and to 0.46 carat per load in 1905. Great quantities of the poorer diamond earth were treated. The total sum realized from the sale of diamonds was £4,802,844; the expenditures were £2,937,509; the profits were £1,865,335. Out of the profits £1,800,000 were paid in dividends, the dividends being 20s. per preferred share as against 27s. 6d. in 1903 and 1904. The reserve was £846,783. The entire sales in 1905 were made "rough" by the syndicate, and this is to continue in 1906, on account of the lower yield and on account of the great demand. This is in spite of the fact that the price of rough stones was raised twice, 5 per cent each time, during the year 1905; but the diamond syndicate makes these advances because there are less diamonds found to-day than there were found fifteen years ago, while the demand for them has greatly increased.

Premier (Transvaal) mine.—The increased output of the Premier (Transvaal) mine has caused great interest in the production of diamonds; and the finding of the largest known diamond, the Premier or Cullinan, weighing 3,024 carats, and of several other large stones, one of which weighed over 600 carats and another 340 carats, has given this mine the greatest record for producing material of exceptional size.

Orange River Colony mines.—The extensive development of diamond mining in the Orange River Colony is well shown in the Annual Report of the Mines Department of that Colony for the year ending June 30, 1905.[a] This report, by

[a] Mines Dept. Orange River Colony, Ann. Rept. for the statistical year ending June 30, 1905; Bloemfontein, 1905, p. 31.

Mr. Burnet Adams, acting chief inspector of mines, tells of steady increase in the diamond output of the colony and describes the condition of the producing mines, besides the Vaal River alluvial diggings, and of more than fifty prospects and partially developed undertakings. In regard to these latter, many have proved disappointing, but some have yielded good diamonds and may prove to be valuable properties.

The seven mines that have actually yielded more or less successfully are (1) the New Jagersfontein (the old celebrated mine reorganized under the new government); (2) the Koffyfontein; (3) the Ebenhaezer; (4) the Lace Diamond Company; (5) the Monastery; (6) the Kaalvallei; (7) the New Driekopjes. Of these, the last is now closed and for sale, and two or three of the others are partially suspended and either engaged in testing or in awaiting improved appliances. The Jagersfontein is much the most important and has been steadily advancing, both in equipment and in production. Heretofore it has been carried on as an open working, but steps are now being taken to change to the underground system, as was done with such success in the De Beers and Kimberley mines.

The diamond output of the colony for the year covered by the report is given in a tabular form by months, from July, 1904, to June, 1905, inclusive. These show some variations, but maintain a fairly uniform average. The product is given as a whole, without distinguishing the mines, but the Jagersfontein far exceeds all the rest together.

Output of diamonds in Orange River Colony, fiscal year ending June 30, 1905.

Loads washed	3,556,000
Carats of diamonds found	320,548½
Value of same	£938,617, 15s. 6d.
Carats per load	0.0899
Value per carat	58s. 8d.
Value per load	5s. 3d.

Subsequent data for the month of July, 1905, show but slight differences from the average of the month preceding. The cost of mining per load is not given in the report.

On comparing these figures with those of the De Beers group of mines at Kimberley for the same period, it is seen that the blue ground is comparatively very low in its diamond content, but that the average value of the stones per carat is considerably higher than for those of the richest of the other group—the De Beers and Kimberley. The total number of loads washed is nearly two-thirds that of all the De Beers group together; while the total diamond product is less than one-sixth, but its value exceeds one-fifth.

The average number of men employed in the diamond mines of the colony, month by month during 1905, was 526 whites and 4,659 natives. With some fluctuations there has been a general increase of the total number during the year, from 4,458 in July, 1904, to 5,496 in July, 1905. The average monthly wages paid for mining and prospecting in the Orange River Colony are given in a recent article as £20 7s. 7d to white men and £3 1s. 6d. to natives.[a]

BRAZIL.

Diamonds and carbonado in Bahia.—Considerable space has been given in recent reports of this Bureau to the diamond and carbonado industry of Brazil. An important article has appeared within the last year on the geology of the

[a] Jewelers' Circular Weekly, October 11, 1905.

Bahia region by Prof. Orville A. Derby, who was engaged by the State of Bahia to study the geological occurrence of the carbonados. The article in question is his report of this work, and has been translated into English by Prof. John C. Branner for publication in this country.[a]

The region examined was the basin of the Paraguaçu River, the upper part of which contains the Chapada Diamantina, or diamond plateau of Bahia. The river traverses four regions or belts of entirely distinct geological character. The first of these takes in all the headwaters of the Paraguaçu and its main affluent, the Santo Antonio; the second reaches from the Falls of Passageni de Andarahy, some 50 miles, to Bededouro; the third extends about 200 miles, down to Maragopipe, and the fourth is a narrow belt adjacent to the coast.

The diamonds and carbons are characteristic of the first region, and occur occasionally in the second and third. At all the localities examined by Professor Derby they appear in connection with a thick bed of conglomerate about the middle of the hard sandstone formation. In many places, indeed, he states that the gravels worked for diamonds are simply this same conglomerate decomposed in place, and not a more recent superficial deposit. This fact has already been recognized in the State of Minas Geraes, where also, at Grao Mogol, diamonds have been taken from the hard conglomerate itself. It is clear that in Brazil the conditions of diamond occurrence bear no resemblance at all to those in Africa. All the indications point to the conglomerate as the source of the diamonds, and the recent unconsolidated gravels are richest in the vicinity of outcrops of this rock, which miners call *pedra cravada*.

If this determination of the conglomerate as the home of the diamonds be correct, Professor Derby remarks, the supply must be enormous, and all that has been done heretofore is trivial in comparison. Only a small part, however, of the deposits can be worked with the methods in use thus far. Whether modern scientific processes, using the hydraulic power so abundant in the region, can operate the beds at an actual profit remains a question for future solution.

Elsewhere than in the vicinity of the Serra das Lavras and its conglomerate there are few diamond occurrences, but still some are known that have interest. Along the bed of the Paraguaçu, in particular, there are various points where diamonds are obtained by diving, and some of these are so far from the Serra that it is not easy to see how the source can be so distant. The principal locality is at the Falls of Funil, near Bebedouro, on the eastern edge of the second region or zone mentioned above. Here the fall is formed by a heavy bed of conglomerate resembling the one in the first zone, but almost certainly of later age. It rests upon granitic rocks and its pebbles are largely thence derived, so that the "formaçao," or diamond gravel, is quite different from that of the first zone. The sandstone of the second zone, however, must be largely derived from the first, and the contained diamonds may be thus accounted for.

These accounts should be compared with that by Mr. H. W. Furniss, dealing with the same region and reviewed in the report of this Bureau for 1902.[b]

There is another diamond region in Bahia—that of Cannavieras and the valley of the Pardo River, and the southern part of the State.[c] This, Professor Derby remarks, is the only diamond occurrence in Brazil at all near the sea. It is a region of but slight elevation, only about 100 meters, largely wooded, and with a thick soil that obscures the rocks. At points, however, in the val-

[a] Econ. Geol., vol. 1, No. 2, Nov.–Dec., 1905, pp. 134–142.
[b] Mineral Resources U. S. for 1902, U. S. Geol. Survey, 1904, pp. 816–822.
[c] Ibid, p. 816.

leys of the Pardo and the Salobro a heavy conglomerate with granitic pebbles is exposed near the diamond washings. One diamond of three grains was obtained for Professor Derby in a test made on 1½ cubic meters of decomposed conglomerate selected by him. Thus, again, diamonds are apparently traced to a widespread bed of conglomerate, here quite near the coast, easily recognized, and suggesting extensive possibilities for investigation and development.

NEW SOUTH WALES.

A valuable guidebook to the mines and minerals of New South Wales has lately been issued under the direction of the minister for mines and agriculture in that colony, Hon. S. W. Moore.[a] In this work references are made to the occurrence of diamonds at several points, which have been noted from time to time in former reports of this Bureau.

The more recent and more important diamond districts around Bingara and Inverell are situated near the Queensland border. Bingara is 378 miles north of Sydney, and Inverell and Tingha are both nearly 40 miles east of Bingara. The divisions named from the two latter places contain much tin in the drift, while the Bingara division is worked principally for gold. With regard to diamonds in particular the guidebook says that near Copeton, in the Inverell district, are numerous isolated hills capped with basalt, beneath which are sands and gravels, with tin, diamonds, and some gold. These hills have been variously named, one of them being the celebrated diamond locality of Boggy Camp. It was in this district that the discovery of two small diamonds in a basaltic dike was made in 1904 at Oakey Creek, near Copeton.

The Bingara division presents conditions somewhat similar, yet with some differences. The chief diamond yield has been from patches of gravel capping the foothills of the basalt-covered range some five miles to the southwest of Bingara.

It is in the Bingara district, at Ruby Hill, that the eclogite-bearing pipe was observed in 1902, which led to so much discussion as to eclogite being the probable source of the diamonds.[b] The guidebook states that there has been but little activity of late in these fields owing to low prices for the diamonds, which are all of small size.

The statistics for New South Wales, given in this volume, state the diamond yield for 1904 as 14,296 carats, valued at £11,620, and the total production to the end of that year as 147,955 carats, valued at £98,223 17s.

Large diamond at Mount Werong.—The fact, after years of working at various points, that only small diamonds had been found, led naturally to the belief that no large diamonds were to be expected in Australia. Within the past year, however, a diamond of nearly 29 carats has been discovered at Mount Werong, 136 miles west of Sydney and 30 miles south of Oberon. It was found at a depth of 12 feet by two gold miners, who were not diamond miners and who did not know what it was. They kept it for some months, and were offered a few pounds for it on two occasions, but suspected that it might be more valuable. Finally it was sent to the state department of mines at Sydney, where it was recognized at once, and its value then proved to be £200. The stone is a distorted and flattened crystal, measuring 23 by 15 by 5 mm., flawless, and of a straw yellow. Appreciating the importance of this discovery, Mr. E. F. Pittman, of the department of mines, promptly visited the place and made a report

[a] A Guidebook for the Use of Prospectors in New South Wales; Sydney, 1905, pp. 156, with map.
[b] Mineral Resources U. S. for 1902, U. S. Geol. Survey, 1904, pp. 824–826.

upon it, which is reviewed by Mr. John Plummer in the Mining World of October 21, 1905.[a]

Mount Werong is one of the peaks of the mountain range, some 4,000 feet high, which separates the fertile coast region from the arid interior. In the beds and ravines of the streams that drain the ridge much of the drift gravel is found washed down and redeposited, and here occurs gold, with zircons and sapphires, abundant but small, and also this large diamond, and another found some years ago, and valued at £5. The sapphires have undoubtedly come from the decomposed basalt overlying the drift, as none have been found in the drift itself. The diamond Mr. Pittman refers to the drift; but he also recognizes the possibility of its having come from the basalt, in view of the discovery of one or more diamonds in the somewhat related dolerite at Copeton. This new locality is some 300 miles south of the Inverell and Bingara region.

NOTES ON THE DIAMOND.

Russian experiments in crushing carbons used in diamond drills.—Prof. Alex. M. Mitinsky, of the Mining Academy of St. Petersburg, Russia, is carrying on a very interesting series of experiments in crushing the carbons used in diamond drills.[b] The rate of advance of a diamond drill increases with the pressure up to a point where the diamonds are likely to break. Here the limit is reached, beyond which an economic loss is involved by greater pressure. The object of this investigation was to determine this limit, which had not before been done, and which is of course a very important practical question.

There has been hitherto a remarkable difference in the practice of European and American operators in work of this kind. The former have generally followed an empirical rule of applying a pressure of 2 kilograms per square centimeter on the bottom of the drill, which is equivalent, with ordinary tools, to 1 kilogram per square millimeter on the diamonds. American drillers have used far higher pressures, as much as 50 or 60 kilograms per square centimeter; by the same ratio this would give 25 to 30 kilograms per square millimeter on the stones set in the drill.

Professor Mitinsky, assisted by Mr. S. Woisslaw, the pioneer of diamond drilling in Russia, selected a number of carbons and subjected them to pressure tests. This was done by placing each stone between two metal plates, a harder one representing the rock and a softer one representing the tool. These were connected with a very sensitive press and recording apparatus, with a maximum load of one metric ton. Different metals and different grades of steel were tried, and the half-sum of the areas of the impressions made in the two plates, in each test, was taken as the cross-section area of the diamond that had been pressed into them for calculation of the force exerted per square millimeter of the stone. The first test was to the limit of the press, one metric ton, without breaking, and the determination was 54.3 kilograms per square millimeter. The second stone, a small one, broke at a calculated pressure of 80.6 kilograms per square millimeter. Three other tests had an average of 68 kilograms as the breaking limit, the lowest being 56 kilograms.

These experiments, Professor Mitinsky thinks, show clearly that the pressure on drilling tools can safely be much increased with corresponding advantage in results, and that the Americans, although far in advance of the Europeans, have yet been operating well within the limit of practical advantage.

After these tests Mr. Woisslaw directed his workmen to disregard the risk of breakage and to use the highest pressure attainable with their machinery.

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[a] Min. World, Oct. 21, 1905.

[b] Eng. and Min. Jour., Dec. 16, 1905.

Professor Mitinsky states that the results were very good, and adds that by this method tools can be obtained that can be run safely at a rim speed of 25 meters per second.

Diamond-carbon in meteorites.—Following up his researches on the Canyon Diablo meteorite, Prof. Henri Moissan has published a more extended article describing those researches in fuller detail and also certain conclusions thence derived, together with new experiments as to diamond production.[a] The results shown are (1) that it is only in certain specimens of this meteorite that carbon appears at all; (2) that in some pieces it is present in several forms, as amorphous carbon in two or three distinct varieties, as graphite, and as diamond in two varieties, black and transparent; (3) that these latter are found inclosed in or surrounded by a zone of amorphous carbon and in small fissures which stand in close relation to nodules of troilite and other compounds containing phosphorus and silicon in addition to the sulphur. Microscopic examination shows that even the portions of the iron that appear homogeneous frequently contain small nodules of this character. Professor Moissan judged, from various studies by himself and others, that the metalloids—silicon, phosphorus, and sulphur—all tend to displace the carbon from molten iron, and that an increase in the proportion of nickel, which is found to vary considerably in different parts of the meteorite, lessens the solubility of carbon in the alloy as compared with pure iron. These two conditions, therefore, should cooperate to favor the separation of carbon in such a meteorite, as compared with Professor Moissan's former process of diamond production in the electric furnace.

These suggestions led him to undertake a series of new experiments to test the effect of conditions thus modified. These are described in much detail, with the general result that the addition of small quantities of monosulphide of iron, or of silicon, to the crucible of melted iron with carbon, on its removal from the electric furnace and just before its immersion in cold water, appeared to facilitate the production of minute diamonds similar to those of his former experiments, but in larger number and with slight crystallographic differences. The addition of a small percentage of nickel, on the other hand, produced no apparent change from the results with pure iron. The introduction of phosphate of iron not only failed to increase the quantity of diamonds but apparently lessened it. Professor Moissan therefore concluded that the diamond carbon in the Canyon Diablo meteorite has probably been set free from an iron carbide by the action of sulphur, and to some extent of silicon, the latter having also partly united with the carbon to form the silicon carbide which he found in association and which the writer named Moissanite, the natural form of the artificial product carborundum.

The crystallographic features of the microscopic diamonds are described, and the very interesting fact is noted that in a number of instances the little crystals broke spontaneously days or even weeks after their formation, thus presenting a striking parallel to the occasional behavior of diamonds from the blue ground of South Africa.

Considerable space is given to experiment and discussion as to the action of melted iron in solidifying in respect to expansion or contraction. The fact seems clearly shown that pure iron follows the ordinary law, but that iron with dissolved carbon expands in passing to the solid state, producing when confined the enormous pressure which causes the carbon, or some part of it, to crystallize as diamond, instead of all assuming the amorphous or the graphitic form.

Artificial production of diamonds.—Two processes have been announced by German experimenters whereby it is claimed that minute crystals of diamonds

[a] Nouvelles recherches sur la réproduction du diamant, par Henri Moissan: Ann. de chimie et de phys., 8th ser., vol. 5, June, 1905.

have been obtained. One of these is that of A. Ludwig, who has been able to produce such crystals from pulverized carbon heated in hydrogen on a spiral of iron wire in the electric arc under a pressure of 3,100 atmospheres.[a] The other is announced by R. von Hatslinger, who fuses graphite with silicates. He prepares a mixture representing as nearly as possible the composition of the African blue ground, and then introduces powdered graphite. The whole is melted in a crucible, the process being facilitated by using metallic aluminum and magnesium in preference to the oxides of those metals. When the fused mass is dissolved, minute octahedra are found, possessing the physical properties of diamond.[b]

Effect of radium on the diamond.—Sir William Crookes delivered his notable lecture on the subject of the diamond before the British Association for the Advancement of Science at its Kimberley meeting in September, 1905. In this lecture experiments were described in connection with radium in contact with the diamond, which showed that the beta rays from radium preparations had like properties to the streams of inactive electrons in a radiant matter tube. It was found, by exposing fine colorless crystals of diamond to radium bromide undisturbed for more than twelve months that the radium caused the diamonds to assume a beautiful bluish color. This color is very persistent; it was affected neither by heating in strong nitric acid nor by potassium chlorate. Furthermore, the radium had communicated to the diamonds radio-active properties strong enough to affect a photographic plate; and when they were heated to a dull redness in a dark room a faint phosphorescence spread over the stone just before the color became visible.

Sir William Crookes also announced the results of his experiments in examining the extreme hardness of the metal tantalum, produced by Messrs. Siemens Brothers, of Berlin. He found that a diamond drill making 500 revolutions per minute and continued in operation for three days and nights had only produced a depression of one-fourth millimeter in depth, the question being then as to which had been affected the more, the diamond or the tantalum.

Wages in diamond-cutting industry.—For the last two years there has been a great deal of disturbance in the matter of the adjustment of the rates and hours of labor in the diamond-cutting industry. The outcome for the United States has been that in November, 1905, an eight-hour day was established, with wages ranging from $40 to $80 per week for the various employees in the industry. This result was brought about by the great demand for cut material and by the fact that the amount of cutting in the United States has increased so rapidly within the last five or six years that at the present time more than one-half of all the diamonds sold in the United States have been cut here. As the high quality of the cutting is not excelled in any of the foreign centers, and because of the systematic methods in use in this country, there is a possibility of a still greater percentage of the larger stones being cut here. This is not true of the smaller stones.

CORUNDUM GEMS.

CORUNDUM.

NORTH CAROLINA.

The first volume of the North Carolina Geological Survey reports[c] treats of the history of corundum mining both as an abrasive and as gem material.

[a] Chem. Zeitung, XXV, 1902, p. 979.
[b] Monatsh. Chemie, XXXII, 1902, p. 817.
[c] Pratt, J. H., and Lewis, J. V., Corundum and the peridotites of western North Carolina: North Carolina Geol. Survey, vol. 1, 1905.

Mining for the abrasive has been frequently successful, but, although the gem mining has produced interesting results, there never has been a financial return to warrant the expenditure for this purpose.

INDIA.

In his recent review of Mineral Production in India for the years 1898 to 1903,[a] the Director of the Indian Survey, Dr. T. H. Holland, gives data supplementary to his special treatise on the occurrence of corundum. Corundum is widely distributed throughout the Mysore State, and a certain amount of working is done at several points, though it can hardly be called mining. There has long been a local trade and a local consumption in India; but Doctor Holland doubts if it will ever be profitable to develop the workings on a large scale, in view of the competition of foreign corundum and of cheap abrasives like carborundum. The native demand, that of the old *saikalgar*, or armorer, and the lapidary, is mainly at a few points like Delhi, Agra, and Jaipur, and has been supplied by the irregular and casual gathering by agriculturists and cowherders. The data of production in Mysore are very variable and evidently imperfect, ranging from 28 tons to 150 tons, worth from about £100 to £700.

CEYLON.

With regard to corundum in Ceylon, the Report of the Mineralogical Survey of that Island for 1904,[b] by the Director, Mr. A. K. Coomeraswamy, gives quite a full account, divided into two sections, one on corundum for abrasive use, and the other on the gem varieties. The first part deals in some detail with the occurrence of blue crystals in the soil at Haldummulla, mentioned in Mr. Coomeraswamy's paper on the Rocks and Minerals of Ceylon.[c] The crystals on the Haldummulla estate have been traced over a considerable area to the foot of a steep jungle-covered bluff, impossible to explore without heavy cost, but clearly the source of the loose corundum. The crystals are accompanied over the area examined by pieces of the matrix, which is sillimanite rock with garnets, containing corundum crystals identical with the others. Orthoclase microperthite is associated to some extent, and a little of either rutile or ilmenite, but these never appear together.

The second part of the report, on the Ceylon gems, is the fullest that has appeared for some time. The gem corundums of Ceylon are obtained entirely from gravel beds, together with lower grades of corundum and also spinels, zircons, tourmalines, beryls, topazes, etc., that have long been known as Ceylon gems. Most of these are supposed to have come from the intrusive granite rocks of the Balangoda group, but tourmaline alone has actually been found in a granite matrix on the island. The hills and ridges are so covered with jungle that it is well nigh impossible to trace the sources of the minerals brought down by the streams. The gems and other heavy minerals thus transported are to a large extent very local in distribution, indicating that their sources are in many small outcrops.

The "gemming" industry of Ceylon is described at some length, with maps and illustrations. The stones are all found in a bed, or sometimes in two beds, of rounded quartz pebbles and cobbles, called "*illam*," which is widely distributed through the valleys and lowlands beneath a more or less thick deposit of alluvium of varying character. The *illam* is sometimes above the level of the

[a] Geol. Surv. India, vol. 32, pt. 1, 1905, p. 105. See also vol. 30, pt. 3, 1901, p. 169.
[b] Ceylon Administration Repts., 1904; Mineralog. Survey, pp. E-1, E-3, E-11, and E-19.
[c] Rocks and Minerals of Ceylon, Spolia Zeylanica, vol. 11, pt. 9, 1905, pp. 50–66.

streams, where the latter have deepened their channels by erosion, but it is more frequently below the water level, in one case as far as 120 feet. To a large extent, it underlies swamps and rice fields. The working of the available localities has been carried on so far and so long that many of them are wholly exhausted and the rest are being rapidly reduced.

The corundum appears in several varieties, and the interesting fact is noted that while the crystals before described, from the Haldummulla and neighboring localities, in connection with the sillimanite rock are prismatic, those from the gem gravels are usually bipyramidal. The varieties found are the following:

1. Korundugal—opaque and only used as an abrasive.
2. Dalam—semitransparent, inferior; sold by the pound.
3. Nila—blue sapphire.
4. Ratukete or Arunal—asteriated.
6. "Topaz,"—Oriental topaz, yellow sapphire.
7. "King topaz,"—clear pink or flesh-colored corundum.

The topaz of Ceylon is yellow sapphire; true topaz is not rare in the gravels, but it is never yellow, being either white, pale-green, or brownish-yellow. (See under Topaz.)

The methods of working the gem gravel are described in detail, and are closely similar to the native methods used in mining for rubies in Burma and for diamonds in Borneo.

The *illam* generally rests upon decomposed rock in place, called "*malawa*." In some cases the lower portions of it are cemented by iron oxide into a sort of conglomerate. In the present beds of rivers in the gem district, especially those that are fast and shallow, the actual surface gravel is gem bearing, forming a modern *illam*, doubtless largely derived from the older one, which represents the accumulation of ages.

The principal region where these gem gravels occur is the Sabaragamuwa province (Ratnapura district), and some parts of the southern province of the island.

SAPPHIRE.

MONTANA.

The sapphire workings at Yogo Gulch, Montana, are being gradually developed into a great and permanent mining industry. They have been noticed frequently in the reports of this Bureau for the last ten years, and a general statement of the disposition of the properties of the two companies engaged upon the gem-bearing dike was given in the report for 1901.[a] The English company, known as the New Mine Sapphire Syndicate, has been thus far the largest producer and the one most prominent before the public; but the other, the American Sapphire Company—frequently called the Yogo Mining Company—has been engaged in extensive prospecting and developing work, and is now preparing to begin active production on a larger scale than any heretofore attempted in Montana.

Taken as a whole, the Yogo dike is judged by qualified experts to be perhaps the greatest gem mine in the world. It extends some 4 miles in length on the surface, and being a true igneous dike, descends to an unlimited depth. If estimated down to 2,000 feet, below which possible working becomes questionable, and at an average width of only 6 feet—although it is often much wider—the entire content of sapphire-bearing rock would approximate 10,000,000 cubic yards.

[a] Mineral Resources U. S. for 1901, U. S. Geol. Survey, 1902, p. 736.

A full report upon the whole locality, though with special reference to the American company's property, has lately been prepared by Mr. George W. Tower, jr. The area of holdings comprises a total of some 800 acres of land—300 acres under quartz-claim patent and 500 acres or more under placer patent. There are 16 patented quartz claims and 1 unpatented, and 13 patented placer claims and 1 unpatented. Some of the latter were worked for gold ten years ago, and Mr. Tower states that the first sapphire discoveries were made in cleaning up the washings of these placers. A full year elapsed before the importance of this discovery was realized, and the gems were traced to their source in the dike. Prospecting and tracing out of the dike then went on for some years, since which time (1901) there has been no further extension of the dike recognized, and no other dikes have been found in the vicinity. The main one has been quite thoroughly explored and its extent determined, as already described.

The dike runs nearly east and west and cuts almost vertically through several thousand feet of stratified rocks, horizontal or slightly inclined, from the Carboniferous down to the basal complex. In width it varies from 4 to 16 feet, and in texture it is to a large extent soft, friable, and easily weathered.

Mr. Tower's report gives details of the workings of both the companies, the English company east of the crest of Yogo Hill, and the American company west of it, to and beyond Yogo Creek. Extensive tunnels, shafts, and levels have been driven, and in the eastern portion also great open cuttings, besides a number of trial shafts and pits. Mr. Tower regards the present twofold division of working as unwise and costly, and strongly advises some form of consolidation and the concentration of work at the American company's openings at the Fourth of July claim, on Yogo Creek, the tunnels here to be made the main thoroughfare for the entire group of workings to the eastward. Here the creek yields abundant water for washing at all seasons, and the American company has run over 2,000 feet of tunnels into the dike rock, besides shafts and cuts to prove its extent. These tunnels, Mr. Tower advises, should be extended and connected with the openings eastward of the hill; thus forming one system and doing away with the expense of hoisting now involved in the English company's shafts.

The American company's work has hitherto been chiefly for development, their only output of gems being those taken out in this process. But now, the extent and richness of the property having been fully determined, they are erecting a plant for mining on the scale of 100 tons per day. This will quadruple the previous output of both companies together, and promises to make Montana sapphire mining a very important factor in American gem production.

The stones obtained are not of large size. They range from "culls," used for watch jewels and other mechanical purposes, to gems averaging, when cut, from half a carat to 2 or 3 carats and rarely up to 5 or 6. As gems they are brilliant, free from flaws, and of good color; ranging from light shades to the rich deep blue of oriental sapphires. The "culls" are produced abundantly, but not in quantities equal to the demand. They sell immediately at from $2 to $6 per ounce, and advance orders can be had without apparent limit. The Yogo crystals have an advantage for mechanical uses over East Indian stones in their form, which is largely short prismatic or rhombohedral with flat basal terminations; and hence they need much less cutting for such purposes as watch jewels and the like.

As to gems, no very full data can be given; but the shipment for the month of November, 1905, from the American company's mines to New York was 1,564 carats in the rough. These are sent for cutting to Amsterdam, and will

yield from two-fifths to one-half that weight of finished stones. Their value will, of course, depend on their size and quality after being cut.

RUBY.

BURMA.

The head of the Geological Survey of India, Dr. J. H. Holland, in his recent review of the mineral production of that country from 1898 to 1903,[a] has given some additional data regarding the Burma ruby mines, which have now become an important source of profit. With regard to other locations in Burma, Doctor Holland states that leases have been granted for several ruby enterprises near Nanyaseik, in the Myitkyina district, and in the Sagyin Hills, in Mandalay district, but that little result has followed. He gives the value of the annual output since that time as follows:

Value of ruby production, Mogok district, Burma, 1898–1903.

1898	£57,950	1901	£104,476
1899	90,848	1902	86,895
1900	97,326	1903	98,575

Of the receipts for 1903 nearly one-half (£44,950) were profits. The falling off in the previous year was due to disastrous floods, against the recurrence of which extensive engineering precautions have been undertaken. Rubies of large size are very rare and enormously valuable. Three remarkable stones were obtained in 1899, one of which was the finest ever found since the opening of the mines to European development. This ruby weighed 77 carats and was sold for 4 lakhs of rupees, or £26,666.

EMERALD.

COLOMBIA.

The Colombian Government has recently employed a well-known expert, Mr. Lloyd-Owen, to make an examination of the condition and prospects of the great emerald mine at Muzo, northwest of Bogota. He has prepared an extended report, of which a copy was furnished to United States Minister Russell, at Bogota, for the Department of State, and an abstract was given in the United States Consular Reports for August 3, 1905.[b]

Mr. Lloyd-Owen states that the emerald-bearing area at and near Muzo is very extensive and has never been thoroughly tested or even explored. It probably covers many square leagues, the Government holdings alone being estimated at nearly 100,000 acres.

NEW SOUTH WALES.

In the recently issued guidebook published by the Colonial Government of New South Wales,[c] reference is made to the emerald locality near Emmaville, which has been occasionally reported. The region is rich in minerals, and the Emmaville and Deepwater divisions are centers of mining for tin, chiefly as stream ore, but also in the "greisen," in which wolfram and scheelite are likewise found. The location of Emmaville is about 100 miles from the coast, some 450 miles north of Sydney. Inverell, noted in connection with the New South Wales diamonds, lies to the southwest, less than 40 miles distant. The emerald

[a] Rec. Geol. Surv. India, vol. 32, pt. 1, 1905, pp. 77–78.
[b] U. S. Cons. Repts., Aug. 3, 1905, pp. 10–12.
[c] Guidebook for the Use of Prospectors in New South Wales, issued by direction of the Hon. S. W. Moore, Minister for Mines and Agriculture; Sydney, 1905, pp. 156, with map.

locality, known as "The Glen," is 9 miles north by east of Emmaville, and the guidebook states that a considerable quantity of emeralds was obtained there some years ago, but that the pegmatite dike, in which they were found, was lost or cut out at the 50-foot level. Systematic search might recover it, and there are other similar dikes in the vicinity which should also be prospected for emeralds. These dikes are offshoots from a large granitic mass intruded among claystones, which are thought to be of Carboniferous age. The dike that yielded the emeralds was a small one, varying in width from a few inches to 4 feet, and also in character from a typical "greisen" at some points to a pegmatite at the gem locality.

BERYL.

CALIFORNIA.

Mr. H. C. Gordon reports the finding of some magnificent groups of pink beryl crystals, measuring 1½ inches in diameter, of the flat type of crystal, rich pink in color, but attached to albite rock, in the Esmeralda mine, Mesa Grande, San Diego County, Cal.

NORTH CAROLINA.

Mining for beryl has been carried on more or less extensively in North Carolina, but without much result. It was found, however, in the Spruce Pine region that by deeper mining blue beryls were frequently obtained at a greater depth than any previously taken out, and in some quantity. Many gems have been obtained weighing from three-fourths of a carat to 2 carats each, but few are over 4 carats in weight.

TOPAZ.

CALIFORNIA.

The white and blue topazes from the Ramona district, San Diego County, Cal., described in the report of this Bureau for 1904,[a] were well represented in the gem exhibit of San Diego County at the Lewis and Clark Exposition, at Portland, Oreg., in 1905. Large specimens of the associated minerals—albite, orthoclase, garnet, tourmaline, etc.—were displayed, showing the topaz in its natural environment, and then as separate crystals and as cut gems.

AUSTRALIA.

Mr. C. Anderson, mineralogist of the Geological Survey of New South Wales, gives some further accounts of the topaz occurrences in that colony and also in Tasmania,[b] described by him in the previous volume of the Records and noticed in the report of this Bureau for 1904. The article is mainly crystallographic, describing and illustrating some particularly fine examples recently obtained from the several localities before reported. No additional facts of any importance are given concerning the mode of occurrence, as previously described, at Emmaville and Oban, in New South Wales, and at Mount Cameron, Flinders Island, and Bell Mount, Tasmania, save the mention of the existence of pale pink and yellow varieties in Tasmania, which had been reported as not found there. Some of the crystals from Flinders Island, Killicrankie Bay, are of remarkable size, up to several inches in diameter.

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[a] Mineral Resources U. S. for 1904, U. S. Geol. Survey, 1905, pp. 979–982.
[b] Rec. Austral. Museum, vol. 6, pt. 2, Sept. 15, 1905, pp. 83–89.

BRAZIL.

A recent letter to the writer from Mr. H. Kilburn Scott, a mining engineer residing at Rio de Janeiro, gives some interesting notes on topaz mining at the Ouro Preto locality, in the State of Minas Geraes. The principal mine—the Boa Vista—has been worked for some years past by a firm employing about twenty men. The method has been to excavate to some depth the overburden formed by slides and the caving of the decomposed inclosing rock and then to run small inclined shafts to reach the topaz-bearing deposit. There has thus been formed a great craterlike excavation, in which the clay carrying the topazes has been followed down some meters below the drainage level. Hence it is possible to work the mine only during the dry season, and with the present method the limit of working has probably been reached. To operate this mine successfully improved methods will be necessary.

CEYLON.

Among the precious stones gathered from the widely distributed gem gravel of Ceylon, topaz is fairly abundant, but the bright yellow variety is absent. What is spoken of as topaz among Ceylon gems is the rarer and harder oriental topaz, or yellow sapphire. The name of "king topaz" is also applied to pink or flesh-colored sapphire. The true topazes of the gravel are either colorless or light green, occasionally also pinkish-yellow or yellow-brown. The first variety is cut and sold under the name of water-sapphire, which belongs properly to iolite (cordierite); the name is entirely misapplied, as the true water-sapphire is blue. The green topazes are sold, with true beryls, as aquamarines. The pinkish-yellow stones closely resemble those from Brazil, but with the curious difference that while the latter turn to a clear pink on being heated (the so-called burnt topaz), the Ceylon stones are absolutely decolorized by heat. The source of the gems is not known, as they are obtained only from the gravel, but it must evidently be in the granite intrusives of the Balangoda group.[a]

ZIRCON.

CEYLON.[b]

A large variety of zircons are found in the gem gravels of the island of Ceylon, with many other precious stones which are a good deal confounded among native dealers and classified largely by color. The Cingalese name *toramalli* is applied indifferently to both tourmaline proper and zircon, and special terms are prefixed according to the color. The green variety is mostly zircon, with some tourmaline and chrysoberyl. The pale brown also includes some tourmaline. Other varieties of zircon found are rich yellow and fiery red. The readiness with which zircon alters in color by heat is illustrated in the fact that many greenish stones become a fine yellow by heating, and that the pale brown ones are often completely decolorized in the same manner to form the so-called Matara diamonds.

NEW SOUTH WALES.

A paper was read several years ago by Mr. D. A. Porter before the Royal Society of New South Wales on the occurrence of zircon in the New England

[a] Mineralog. Surv., Ceylon; 1904.
[b] Ceylon Administration Repts., 1904; Mineralog. Survey.

district of that colony. In a recent article by Mr. C. Anderson, mineralogist to the Australian Museum, this paper is cited and some fresh specimens received from Mr. Porter are described in detail.[a]

The principal localities are at Glen Innes and Inverell, places about 30 miles apart. Mr. Porter describes the zircons as found over a considerable area of basaltic country on the northern watershed of the MacIntire River. They occur in stream beds and in raised banks of clay or gravel along the streams or strewn over the surface of low sloping ridges. The specimens are generally broken and cleaved and much worn, but some good crystals occur, varying from clear colorless to dark red.

TASMANIA.

R. Brauns gives[b] the measurement of the crystals of zircon from Tasmania showing that crystallographically they very strongly resemble those from Russia. Generally, however, the crystals are very large and rolled; others are entirely rounded. These have been extensively imported at Idar and Oberstein. Many of them are colorless and become violet-brown in color by heating. Others are made entirely colorless by the same process.

GARNET.

OREGON.

Mr. L. Bush Livermore, of Baker City, Oreg., describes a deposit of garnets in the Sutton Creek district, some miles south of Baker City, which he regards as worthy of investigation.[c] He says that near Pleasant Valley, where the principal rock appears to be a black argillite, soft and crushed and with no well-marked planes of bedding, has been found a strong ledge containing garnets resembling rhodolite. Some of these are quite handsome and lustrous, and large enough to cut gems up to 30 carats in weight. Further particulars of this occurrence are quite desirable. Nothing has yet been done to develop it.

ESSONITE.

CALIFORNIA.

A curious occurrence of garnet is reported by Mr. F. M. Sickler, as noted by himself and Mr. George Frey at a point some 7 miles from Pala, San Diego County, but not otherwise specified. The association here was of the Ramona type—essonite garnet with beryl, the former varying from light yellow to ruby-color. The garnets occur in rounded pieces like pebbles or nodules. These were found to be, apparently, remnants or cores of larger crystals that had decomposed, leaving their original form as casts in the feldspar matrix. Besides the garnet cores these cavities contained mica and red clay, doubtless products of alteration from the garnet crystals that have partly disappeared.

A fine display of garnets of various shades, chiefly from the Ramona district, was made in the San Diego County exhibit of gem minerals at the Lewis and Clark Exposition at Portland, Oreg., in 1905.

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[a] Rec. Austral. Museum, vol. 6, pt. 2, Sept., 1905, pp. 95–96.
[b] Separat-Abdruck aus dem Centralbl. für Mineralogie, 1905, pp. 483–485.
[c] Mining Record, July 29, 1905.

PYROPE.

NEW YORK CITY.

An interesting discovery of pyrope garnet has been made in constructing the rapid transit tunnel from the south end of Manhattan Island to Brooklyn. This tunnel runs from the Battery at the foot of Whitehall street to the foot of Joralemon street, Brooklyn. About 1,000 feet south from the New York starting point, beautiful grains or nodules of pyrope were obtained, capable of being cut into gems of three-fourths of a carat to 1 carat in weight. These were in connection with serpentine, of which the writer found many pieces on examining the dumps—some of it of the green precious variety—together with kerolite, but he did not succeed in obtaining any that actually contained pyrope.

Pyrope is a mineral belonging to igneous rocks, especially peridotites, from the alteration of which serpentine is frequently formed. The serpentines of New York and vicinity are now quite clearly shown to have originated in this way.[a]

TOURMALINE.

CALIFORNIA.

The colored tourmalines of the Pala district, in San Diego County, Cal., were finely shown in the mineral exhibit of that county at the Lewis and Clark Exposition, at Portland, Oreg., in 1905. The principal displays were of rich, deep-red rubellite, from the Pala Chief mine, and of various colored tourmalines, though mainly pink rubellite, from the San Diego Company, of Mesa Grande. All these were shown in fine specimens, both in crystals and in cut form.

CONNECTICUT.

Information has been received from Mr. S. Ward Loper, of Middletown, Conn., that a new locality for colored tourmaline has been opened in the northeast corner of Portland, Conn., at what is called the Strickland quarry. Besides one very large crystal of deep green color, several fine and clear specimens have been found—all green; no pink ones as yet. This locality is but a few miles from the celebrated one at Haddam Neck.

MAINE.

The year 1905 was not very productive in gem tourmalines from Maine. Considerable mining was carried on for feldspar and mica, and some for lepidolite, but the yield in gem tourmaline was scanty. A letter from Mr. Loren B. Merrill, of Paris, Me., describes his own work at Mount Mica and gives the general facts as to the other localities. The quarries at Auburn have yielded practically no gem material. At Newry a good deal of tourmaline has been found, some of the crystals very large, up to 4 inches in diameter; but at that place the crystals are not in pockets, but traverse the pegmatite in the manner of beryls, and hence are liable to much breakage. At this locality pink tourmaline predominates over green. Mr. Merrill has found numerous pockets at Mount Mica, with much cookeite and quartz crystals, but the tourmalines are mostly small and of pale (green) color. One such pocket was notable for its great size, being 8 feet long by 5 feet wide and 3½ feet deep.

[a] Newland, D. H., The Serpentines of Manhattan Island and vicinity; School of Mines Quart., April, 1901, pp. 399–410.

JADEITE.

BURMA.

Jade, so highly valued in China, has long been known to occur in Burma, and much of that employed by the Chinese has been thence obtained. The latest accounts of it are given in the Review of Mineral Production in India for the years 1898 to 1903, by Dr. J. H. Holland, Director of the Indian Geological Survey.[a] The industry is quite extensive, being second only to the ruby mines in the gem-stone production of India. Jade has usually been obtained from bowlders, etc., but in upper Burma it is found in place and is systematically quarried. The locality is in the Mogoung division of the Myitkyina district, near Tammaw, where the jade forms a light-colored layer in a dark-green serpentine, which is apparently intrusive in sandstones of Miocene age. Doctor Holland thinks that the jade "must have been separated as a primary segregation from the magma," whence the serpentine was derived.

Some fine material is also obtained from rolled pieces in the valley of the Uru River, an affluent of the Chindwin.

The product is taken into China, partly overland and partly via Rangoon, and thence to the Straits Settlements and China. The trade is quite important, and averaged annually from 1897 to 1903, inclusive, 3,914 hundredweights, valued at £44,770, an average price per hundredweight of £11.44.

All the Indian jade is jadeite, the soda-alumina variety, related to pyroxene. The other variety, nephrite, a lime-magnesia member of the amphibole group, is not known in India at all, or at least of any valuable quality.

KUNZITE, BERYL, TOURMALINE.

CALIFORNIA.

In the report of this Bureau for 1903 [b] a list was given of mines and prospects on Hiriart Mountain, to the east of the Pala and Pala Chief ridges, in which the gem minerals of the district—colored tourmalines, kunzite, beryl, and their associates—were to some extent observed. In the general outline of California gem mines, contained in the report for 1904 [c] an account was given of later developments at one of these mines—the Naylor-Vanderberg. Recent information describes quite active work, with promising results, as having been carried on during 1905 at several of these openings. It is highly interesting to find there are now a number of adjacent localities yielding good indications of the minerals that have already made the Pala region so notable in American gem production, particularly of pink beryl and kunzite, as well as of tourmaline and garnet.

The Naylor-Vanderberg mine already noted has been penetrated by a tunnel nearly 200 feet long, which cuts the main vein in the two mines. This has revealed lithium beryl, kunzite, and a transparent green spodumene, suggesting that found years ago in North Carolina. A rare ferro-manganic phosphate of purple color also occurs here.

The Hiriart mine has been opened by a tunnel for 80 feet; the ledge here consists largely of albite with disseminated lepidolite. Tourmaline was found and some lithium beryl, but no kunzite. The tourmalines were deep grass green, aquamarine blue, and sometimes green with a pink or a black center.

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[a] Rec. Geol. Survey India, vol. 32, pt. 1, 1905, pp. 53–54.
[b] Mineral Resources U. S. for 1903, U. S. Geol. Survey, 1904, p. 942.
[c] Mineral Resources U. S. for 1904, U. S. Geol. Survey, 1905, p. 972.

The White Queen mine (at which the original discovery of kunzite was made in 1902) has been further opened by a cut in the main ledge, which revealed lepidolite and gem pockets. Salmon-pink lithium beryls were the principal gems found, some being very fine specimens. Gem tourmaline was also encountered to some extent, but nothing is reported of kunzite.

In the Catarina mine a large open cut has been made, and good material was shown. The "pay streak," or central gem-bearing zone of the ledge, varies from 2 to 4 feet in thickness and consists of quartz, albite, and lepidolite. Several pockets were found, containing chiefly quartz crystals and violet-colored kunzite. Another opening, one hundred yards to the east, revealed similar pockets, with pink kunzite and some indicolite, together with quartz crystals, often clear and fine. One pocket yielded nearly a ton of crystallized quartz, some individual crystals weighing as much as 40 pounds.

The Anita mine was tested by several cuts and yielded quartz crystals, lepidolite, and good pink kunzite.

The Sempe mine was opened on two ledges, and fine pink beryl was taken from one and white beryl from the other.

The San Pedro mine is traversed by the same dike or vein as the Catarina and the Naylor-Vanderberg. In this a large open cut showed pink beryl, pink kunzite, green tourmaline, and fine quartz crystals.

A fine display of kunzite, both in the natural state and in cut forms, was made in the mineral cases of the San Diego County exhibit at the Lewis and Clark Exposition at Portland, Oreg. These came from the mine on Pala Chief Mountain, and included large, well-colored crystals and fine, violet-tinted cut stones, one weighing 150 carats and another 80 carats, besides other cut kunzites mounted in jewelry, with pearls, etc.

QUARTZ.

TEXAS.

Beautiful, small crystals from 2 to 3 mm. in diameter, doubly terminated and of absolute purity, resembling those from Herkimer County, N. Y., have been found near Mullen, Mills County, Tex., by Mrs. Ellen Oxley.

ROSE QUARTZ.

COLORADO.

A magnificent vein of rose quartz has been located by Mr. W. C. Hart, of Manitou, Colo., 25 miles west of Fort Collins, in Larimer County, Colo. The quartz vein crosses the road between Stove Prairie and Box Prairie at an altitude of 8,000 feet. The country rock is granite, with quartz veins running through the granite. Pieces weighing from 1 to 1,000 pounds could be taken out. There is a large body of the quartz, the vein in places being 3 feet thick. Some 21,000 pounds were taken out during 1905.

AMETHYST.

NORTH CAROLINA.

From time to time amethysts are brought in from localities in North Carolina, and especially from the region of Rabun Gap, Georgia, on the North Carolina border, although no quantity seems to exist to warrant mining at present. Yet many of the stones afford such rich brilliant gems that at no foreign locality have choicer gems been found.

QUARTZ GLASS.

Quartz fused for chemical ware.—Attempts have been made to manufacture articles for chemical use from quartz glass, and it seems that this result has been lately attained. Three chemists in Germany—Herceus, Siebert, and Kuhn—have succeeded in blowing flasks of ordinary laboratory sizes from fused quartz. The mineral is melted in crucibles of iridium or iridium-ruthenium by the oxyhydrogen flame in a furnace of lime or magnesia. The difficulty in previous attempts has been that the quartz glass produced was full of bubbles. But these escape if the quartz is kept in fusion for some time, and this can be done in a crucible of iridium which will sustain a temperature of 2,200° C., as quartz requires for the vitreous modification only about 1,700° C. The operation of blowing the quartz glass is one of extreme delicacy. The vessels produced are almost completely unaffected by acids or salts, but naturally are attacked by alkaline solutions.

NONCRYSTALLINE QUARTZ.

AGATE.

INDIA.

Agate is obtained in considerable quantities in India and is exported both to Europe and to China, as well as worked at some points by native lapidaries. Its source is in the amygdaloidal portions of the Deccan trap flows, and it is collected at numerous places along or near the edge of the trap, especially in the State of Rajpipla, from a conglomerate near a village named Ratanpur. The principal place where it is sold and cut is Cambay, in the Bombay Presidency, though agate cutting is also done at Jabalpur and some other points. Data as to quantities and values are not readily obtainable.[a]

MOSS AGATE.

WYOMING.

An extensive demand for the moss agate found in Hartville district, Wyoming, is reported, a single party having taken out 4½ tons of this material, which was sold in Germany at an average price of $200 per ton.

JASPER.

CALIFORNIA.

An outcropping of jasper 2 feet wide has been uncovered in the brushy country near Dulzura, San Diego County, Cal.[b] The rock is ribbed in different directions with red and yellow streaks combined with a soft gray. It is claimed that it polishes beautifully, and that the brilliant colors blend most delightfully when polished.

TEXAS.

A remarkably interesting occurrence of jasper has been discovered 20 miles north of Brackettville, Kinney County, Tex., as an outcrop on the mountain

[a] Geol. Surv. India, vol. 32, pt. 1, 1905, p. 107.
[b] Los Angeles Min. Review, Dec. 23, 1905.

side. The jasper occurs in bands of brown and white, yellow and white, and red and white, strikingly resembling that of Trego County, Kans.

OPAL.

OREGON.

In the last report of this Bureau[a] a reference was made to specimens of opal obtained some years ago from Oregon. What seems probably to be this same occurrence is spoken of by Mr. L. Bush Livermore, of Baker City, Oreg., in an article in the Mining Record[b] of July 29, 1905, on the precious stones of that State. The section that he describes is that known as the Burnt River region, an area of some 800 square miles a little south of Baker City. A few miles below the town of Durkee a creek flowing from the slopes of Lookout Mountain cuts through a series of bedded tufas. Here have been found opal-containing cavities in a rhyolitic tufa, the opals somewhat abundant and quite handsome, but frequently with a bluish tint and not very brilliant. A quarry has been opened to test both quantity and quality.

NEW SOUTH WALES.

The opal deposits of New South Wales have been described again in a handbook for miners and prospectors, issued under the direction of the minister of mines and agriculture of that colony, Hon. S. W. Moore, M. P.[c] These interesting and important opal mines have been treated of quite fully in the reports of this Bureau, together with those of Queensland,[d] which are continuous with them and geologically identical. So far as description is concerned little is added in this recent volume, but the extent of the opaliferous area is shown to be wider than heretofore announced. A new region is described much farther east than any previously known, at Wallangulla, in the county of Finch, situated in the Walgett division, about 50 miles north of the town of Walgett, half way to the Queensland border. The rock here is an outlier of the Desert Sandstone (Upper Cretaceous), and the conditions are identical with those in the White Cliffs region, which lies some 300 miles away, in a direction south of west.

The opal from Wallangulla is described as of fine, deep color, and a good deal of it is of the highly prized mosaic or "harlequin" variety. No large quantity has yet been taken out, however, and the field needs to be developed. It is judged that there may be many other good localities in this region, between Walgett and the Queensland border, but the country is remote and difficult of access, and those now at work find it hardly possible to make their expenses under present conditions.

The output from the White Cliffs district since 1890 has been very large, reaching, to the end of 1904, a total estimated value of £873,599, or about $4,250,000. It has increased in the last decade quite irregularly but largely, although in 1904 it fell off seriously. This is attributed to a difficulty in obtaining first-class material, while the lower grades have been produced in excess and have fallen greatly in price.

WEST AUSTRALIA.

The occurrence and the peculiarities of crocidolite opal in West Australia have been noted in the reports of this Bureau for the last three years. In the

[a] Mineral Resources U. S. for 1904, U. S. Geol. Survey, 1905, p. 956.
[b] Mining Record, July 29, 1905.
[c] Guidebook for the Use of Prospectors in New South Wales; Sydney, New South Wales, 1905, pp. 33–34, 42–43.
[d] Mineral Resources U. S. for 1902, U. S. Geol. Survey, 1904, pp. 854–856.

annual report of the Geological Survey of West Australia for 1904[a] the existence of a precious opal at Coolgardie is described by the government geologist, Mr. A. Gibb Maitland. His assistant, Mr. C. F. V. Jackson, was sent to the locality to collect and report. The conditions are peculiar, the opal occurring in a seam or belt of dark, compact, slaty rock, thought to be a metamorphosed phase of the schists and amphibolites of the district. The rock is full of joints and partings, infiltrated with silica, which occupies small fissures and cavities, both as quartz and as opal. The latter is chiefly of the common variety, but is sometimes precious and of fine quality. The veinlets are so small that little opal can be found suitable for cutting, yet in places the cracks filled with opal form such a network that the whole might be worked as a beautiful "matrix" stone. Mr. Maitland feels doubtful as to the prospect of this locality being profitable on any large or permanent scale.

OPAL PSEUDOMORPHS.

NEW SOUTH WALES.

In the White Cliffs opal district of New South Wales there occur many pseudomorphous forms of opal after shells, crinoids, saurian bones, and coniferous wood, and there are also curious masses of grouped crystals, known locally as "fossil pineapples," representing the replacement of some mineral not clearly determined.[b] A paper has lately appeared in regard to these problematic bodies, by Messrs. C. Anderson and H. Stanley Jevons,[c] in which they present the results of a very careful study of some of the best specimens obtained, and, after reviewing and dissenting from the suggestions of previous writers (see Mineral Resources for 1901), are led to believe that the original mineral must have been glauberite.

TURQUOISE.

CALIFORNIA.

In the last report of this Bureau, in the special section devoted to the gem minerals of California, the turquoise mines in the desert region of San Bernardino County were described.[d] It was there stated that these mines had produced a large amount of material, including some stones of unusual size, but that nothing had been done in 1904. Since then considerable quantities of material have been taken out, including many stones of large size, which range from 50 to several hundred carats. Some of the latter have sold as high as $1,500 each. The color is mostly a pale shade, but it has seemed to be popular, and large quantities have been sold in the form of beads for necklaces, etc., either of uniform size or graduated.

PERSIA.

The old turquoise mines near Meshed, in eastern Persia, are still producing quite extensively, notwithstanding the rude methods employed in working them and the competition of the American mines. The registered exports for last year had a value of £9,396, which may represent one-fourth of the total output, as there is a continuous local demand and also probably considerable smuggling. Every Persian must possess a turquoise, good, bad, or indifferent, and fine stones

[a] Ann. Prog. Rept. West Australia, 1904, pp. 19–21.
[b] Mineral Resources U. S. for 1901, U. S. Geol. Survey, 1902, p. 759.
[c] Rec. Austral. Museum, vol. 6, pt. 1, June, 1905, pp. 31–37.
[d] Mineral Resources U. S. for 1904, U. S. Geol. Survey, 1905, p. 966.

command higher prices there than in London, but inferior grades are lower. Large pale turquoises often veined or spotted with white, are exported a good deal to India and sold there quite cheaply. The mines are farmed out by the local authorities for a yearly payment of £5,000, and the lessees in turn rent most of them to other parties.

VESUVIANITE (CALIFORNITE).

CALIFORNIA.

In Bulletin No. 262 of the United States Geological Survey[a] Prof. F. W. Clarke and Mr. George Steiger have given full analyses of the compact variety of vesuvianite, called by the writer californite, from Siskiyou and Fresno counties, Cal., and also of the peculiar white garnet found associated with it at the latter locality.[b] The analyses are recalculated and reduced to a uniform type by eliminating impurities and replacements, and an attempt is made to deduce structural formulas. The white mineral proves to be a true garnet, containing as an impurity about one per cent of calcium carbonate. The variations in these and many other analyses of vesuvianite lead Professor Clarke to the view that this mineral may be a mixture of several closely related molecules. These Californian varieties, and others also, conform very well to the expression

$$Al_2\ Ca_7\ (SiO_4)_6\ (Al\ O\ H)_2.$$

This differs slightly from the formula previously deduced by Dr. Clarke, viz:

$$Al_2\ Ca_6\ (Si\ O_4)_5\ Al\ O\ H,$$

which serves well "for the average composition of the species, but does not fit the extremes." Hence the suggestion of a mixed constitution.

Vesuvianite should be considered as a basic orthosilicate belonging to a group of which garnet is the normal type, with epidote and the scapolites as other members. Their formulas are closely related; they originate similarly from contact metamorphism. They all alter in much the same manner, and yield similar or even identical derivatives.

OBSIDIAN.

MEXICO.

In the report of this Bureau for 1900 was given an account of the great prehistoric obsidian mines in Mexico, near Pachuca, in the State of Hidalgo, as visited and described by Prof. W. H. Holmes. At this point, though the material exists in such quantity, yet no outcrops could be seen, all being buried under the heaps of débris and fragments left by the ancient workers. A recent communication to the author from Mr. J. M. Hamilton, of Tequisquiapan, in the State of Queretaro, describes another locality some 60 or 70 miles west of the former, where a closely similar obsidian occurs abundantly, but does not appear to have ever been mined or developed, and where the outcrops are entirely accessible. The locality is near the border of the States of Queretaro and Hidalgo, on a range of low hills east of the San Juan River, between the crossing of that stream by the Mexican Central Railroad, at San Juan del Rio, and by the National Railroad of Mexico a few miles below.

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[a] Contrib. to Mineralogy: Bull. U. S. Geol. Survey No. 262, 1905, pp. 72–74.
[b] Mineral resources for 1901, U. S. Geol. Survey, 1902, p. 747; Am. Jour. Sci., 4th ser., vol. 16, 1903, p. 397.

Mr. Hamilton describes the obsidian as occurring in parallel "veins" from 6 inches to 2 feet in width, but gives no particulars as to their position or direction. The colors are black, opalescent, and green with dark bands, also a lighter green without banding. He has had specimens polished for sleeve buttons and like purposes, and it appears to be capable of ornamental use and to be procurable in abundance, as Mr. Hamilton states that it can be picked up by wagonloads at the outcrop.

UTAHLITE (VARISCITE).

UTAH.

A very interesting discovery has lately been announced of a new occurrence of this attractive and wholly American gem stone, hitherto obtained from only one locality—at Mercur, Tooele County, Utah—first made known in 1894 and described in the report for that year.[a] The new occurrence is also in Utah, and the particulars regarding it are furnished by Mr. Edward Bird, of Salt Lake City. The location is about 20 miles northwest of the other one, and lies 8 or 9 miles west of Stockton and some 40 miles southwest of Salt Lake City. The mineral appears in a ledge which crosses a little spur or foothill running eastwardly from the main range of the Stansbury Mountains. This hill is some 1,500 feet long from east to west, and rises to a maximum height of 200 feet above the adjacent "bench lands." The variscite occurs in two seams or ledges which traverse this foothill in a northerly and southerly course, dipping steeply westward. The only development thus far done is an open cut on the south side of the foothill or spur, some 10 feet long and 4 feet deep. The surface rock appears to be an iron-stained brecciated quartz. At the west end of the hill, where a little depression separates it from the main Stansbury range, there is an outcrop of brownish laminated quartzite; at the east end appears a strong body of bluish limestone. No metallic veins have been observed in the vicinity.

The variscite itself occurs in the same manner here as at the Mercur locality, in roundish or kidney-shaped nodular masses from the size of a lemon to that of a large cocoanut, with a rough external coating or casing of reddish-brown color, inclosing the beautiful green material within. Mr. Bird observes that this color tends to become deeper in the lower part of the cutting, suggesting an increase of richness with depth; but this point has not yet been established. He also thinks that slabs can be cut from the compact rock, showing the variscite contrasting with the reddish-brown quartzose matrix. Little has yet been regularly taken out, but enough to show the fine color of the green interior, and a number of persons have had charms and ring stones cut from it.

PSEUDO-SERPENTINE.

WASHINGTON.

In a report of this Bureau a description has been given of a very handsome serpentine from the State of Washington, exhibited at the Buffalo and Charleston expositions. A recent article by Prof. F. W. Clarke[b] gives an account of some remarkable peculiarities in this mineral, which lead him to designate it as a "pseudo-serpentine." Analysis shows that it contains a large proportion of (apparently) brucite, intimately mixed with some serpentine, and also a

[a] Sixteenth Ann. Rept. U. S. Geol. Survey, pt. 4, 1894, p. 602.
[b] Clarke, F. W., Contrib. to Mineralogy: Bull. U. S. Geol. Survey No. 252, 1905, pp. 69–71.

chloritic mineral judged to be clinochlore. Numerous tests and experiments are described looking toward exact determination of the mingled components, though the precise distinction of them is very difficult. Professor Clarke says: "The rock is unusual in character; and if the sample examined is fairly characteristic of the entire deposit, the latter should be carefully studied in reference to its origin and its geological relations."

AMBER.

TEXAS.

A yellow, resin-like amber is common in the Cretaceous coals at Eagle Pass and on Terlingua Creek, as is reported by Prof. J. A. Udden. The largest pieces are of the size of a grain of corn, and small pieces can always be easily found.

SANTO DOMINGO.

Mr. Clarence C. Sample, in an account of the occurrence and production of amber in Santo Domingo,[a] states that the locality is identical with that described by Mr. C. W. Kempton in the report of this Bureau for 1903,[b] but it would appear that much progress has been made in the past two years in the matter of production. The hill on the upper Licey River, the locality of occurrence, is one of the foothills of the Monte Cristi Range, which flanks the north coast eastward to Samana, and forms the northern limit of the Vega Real of Columbus, the great central valley plain. The rocks of the Monte Cristi Range are chiefly sandstones and shales, with some conglomerate, and are rather soft and much eroded. Amber is found in them at several points, but the principal district is that of Tamboril, in a region comprising some 50 square kilometers, a few miles north of Santiago.

Many of the beds of shale and sandstone contain carbonaceous matter and some carry lignite, and it is in these that the amber is found, but unfortunately no fossils have been obtained to fix the exact age. Mr. Sample states that the quantity of amber found is only a fraction of a pound to a cubic yard of rock, so that when the latter is at all hard there is not enough amber to render working profitable, as any process of rock crushing would involve breaking up and damaging the amber. It occurs in pieces varying from small sizes up to several pounds, and in color from light yellow to deep red, with also a black variety of little value. The curious fact is noted that the red amber can be bleached by a few hours' exposure to the sun.

BURMA.

Burmite (*Burmese amber*).—Amber has long been known as obtained in Upper Burma, and the recently published "Review of the Mineral Production of India from 1898 to 1903," by Dr. T. H. Holland, Director of the Geological Survey of India,[c] gives some interesting facts regarding its occurrence and production. The quantity and value have varied extremely, but during the years mentioned the annual output has averaged 51 hundredweights, valued at £362. The amber is mined principally in the Myitkyina district, in the Hukong Valley. It occurs in clays, judged to be Miocene, and has also been recognized in similar strata of that age at a few other Burman localities. The product is mostly taken to Mandalay, where it is worked into beads, ear cylinders, and

[a] Eng. and Min. Jour., August 12, 1905.
[b] Mineral Resources U. S. for 1903, U. S. Geol. Survey, 1904, p. 964.
[c] Rec. Geol. Surv. India, vol. 32, pt. 1, 1905, pp. 95–97.

other ornaments for native use. Of late it has been undersold even there by cheap Prussian amber, and the semiartificial ambroid, made from chips and fragments. The supply seems to be quite considerable, although the larger pieces are frequently opaque or discolored, and are injured by cracks filled with calcite. It is hard and very tough, and is thus well fitted for carving and turning. Like that of Sicily, it is often fluorescent.

The name burmite has been given to this amber by Otto Helm as a distinct species from true amber or succinite, in that it contains absolutely no succinic acid. Its analysis is as follows:

Analysis of burmite or Burmese amber.

Carbon	80.05
Hydrogen	11.50
Oxygen	8.43
Sulphur	.02
	100.00

CHRYSOCOLLA.

CALIFORNIA.

Mr. William V. Holley, of Los Angeles, Cal., gives an account of a combination of richly colored copper minerals found at Cima, in San Bernardino County. Chrysocolla, azurite, and malachite are here mingled in compact size, so that the whole may be cut and polished, showing various shades and patterns of blue and green in beautiful manner well adapted to use in ornamental work.

DUMORTIERITE.

The rare blue mineral identified in 1879 by Gonnard and named by him dumortierite, has lately been found at two new localities on the Pacific coast, and is made the subject of an extended discussion by Mr. W. T. Schaller, in Bulletin No. 262 of the United States Geological Survey.[a] In the report of this Bureau for 1892 the announcement was made of the notable occurrence of dumortierite at Clip, Yuma County, Ariz., where it so fills masses of quartz as to resemble lapis-lazuli, and reference was also made to another locality in Riverside County, Cal., where it occurs in the same way, as fibers penetrating and coloring quartz. This was more fully described in the report of 1893, but nothing seems to have been heard since then of this latter occurrence.

California.—Within a year or two past dumortierite has been found in larger quantity and of a different tint in San Diego County, Cal., a few miles east of Dehesa, the place noted for its "orbicular diorite." Here it appears in masses of several centimeters in either direction, with a radiating columnar structure and of a pinkish lavender color, instead of its usual indigo blue. It occurs intermingled with quartz in the lower half of a large dike, the upper half of which contains sillimanite, instead of dumortierite, similarly associated with quartz.

Washington.—Another locality lately announced is in Skamania County, Wash., at the headwaters of the North Fork of Washougal River. Here the form is different again, the mineral being present in minute spherulites composed of radiating fibers of strong blue color. These are distributed through a fine-grained quartz matrix as blue specks, sometimes massed in patches and sometimes abundant enough to color the whole mass. Associated with it is andalusite, apparently taking the place of the closely related species sillimanite at the previous locality.

[a] Contrib. to Mineralogy: Bull. U. S. Geol. Survey No. 262, 1905, pp. 91–120.

Arizona.—At Clip, Ariz., the associated mineral is kyanite; so that these three species, so nearly allied in composition, appear to have close relation with the dumortierite, one or other of the group being in every case associated. The bearing of this fact will be noted presently. Muscovite, also in small quantities and apparently a product of alteration, is present at each of these three western localities. At the New York occurrence, in Harlem, the dumortierite appears in a vein of coarse red pegmatite, and is generally in the feldspar, associated with black tourmaline, muscovite, and small quantities of some other minerals. The French localities near Lyons present a similar mode of occurrence. At a few points in Bohemia and Silesia it is also known, and appears to belong in a pegmatite.

Mr. Schaller's paper goes into a very careful examination to determine the exact composition of this species and its proper place among the silicates. The analysis brings out very clearly the true constitution of dumortierite as a member of the kyanite-sillimanite-andalusite group, differing from andalusite only in a small content of boron.

The average of the two analyses of Dehesa material is as follows:

Average of two analyses of dumortierite from Dehesa, Cal.

SiO_2	28.68
Al_2O_3	63.31
Ti_2O_3	1.45
Fe_2O_3	0.23
H_2O	1.52
B_2O_3	5.37
	100.56

in which the titanium and iron are regarded as replacing alumina. Grouped together, the ratios for silica, alumina, boric acid, and water are almost exactly 6 : 8 : 1 : 1, and yield the formula:

$$8\ Al_2O_3\ 1\ B_2O_3,\ 1\ H_2O,\ 6\ SiO_2,$$

which may be written—

$$(SiO_4)_3\ Al\ (AlO)_7\ (BO)\ H.$$

This, when written graphically, is extremely close to the expression for andalusite, the radical BO, with a hydrogen atom, replacing a part of the alumina. The alteration of dumortierite to muscovite is also shown very readily, alumina and boric acid being set free and potash taken up.

As to the physical properties of dumortierite, the crystallization is orthorhombic, though there is little material to judge precisely upon, the mineral being usually fibrous. The density averages 3.3. Pleochroism is marked and varies in specimens from different localities, being colorless (or rarely pale yellow) to cobalt blue, pistachio green, rose salmon, carmine or red-purple—the latter is found only in the California specimens, and is regarded by Mr. Schaller as due to the titanium present.

LEPIDOLITE.

In the eighteenth century lepidolite was used as a pleasing ornamental stone, polished and cut into such objects as are fluorite and malachite.

In a series of mineralogical notes in Bulletin No. 262 of the United States Geological Survey, Mr. W. T. Schaller describes some features of the crystallization of lepidolite.[a] He has examined a number of crystals from the vicinity

[a] Schaller, W. T., Contrib. to Mineralogy: Bull. U. S. Geol. Survey No. 262, 1905, pp. 139–143.

of Ramona, San Diego County, Cal., and gives a series of observations thereon, which he states are to be more fully presented in a forthcoming paper on the lithia minerals of California. He finds in general a very close relation to muscovite, with certain differences, however, in three respects, viz: That in lepidolite twinning is very rare, the characteristic M face of muscovite (221) is wanting and the *a* face (100) unusual in muscovite, is frequent.

He also describes a mode of occurrence in lepidolite from Mount Mica, Maine, which has very rarely been previously reported. This is the globular aggregation of crystals, which is not infrequent in muscovite. It has been barely mentioned by von Rath, from Elba, and by Doctor Hamlin, from Mount Mica. Mr. Schaller reports it as occurring both at Mount Mica and at Mount Apatite, on Pulsifer's Ledge in Auburn, Me. At both these localities the spheroidal groups attain a size of several centimeters in diameter.

MISCELLANEOUS.

Gem minerals at the Portland Exposition.—The products and resources of the Pacific States were illustrated on a large scale at the Lewis and Clark Exposition held at Portland, Oreg., in 1905. Among these the mineral exhibits were very conspicuous, and the Palace of Mines impressed every visitor. A marked feature in this building was the collection of precious, semiprecious, and ornamental stones of the Pacific coast and adjacent States, which the writer was appointed to prepare. It included representatives of all the more remarkable gem minerals from the entire Pacific coast region and from many points of the interior Northwest, together with some from Arizona and Utah. Most of these have already been described in the reports of this Bureau.

From the Pacific coast proper the most northerly exhibit was that of large crystals of garnet from Fort Wrangell, Alaska. From Prince of Wales Island were shown magnificent large crystals of dark-green epidote, found by accident in mining for copper. Of special interest are the aboriginal celts, hammers, and knives made of green jade, found in graves in Alaska. Lieutenant Storey, U. S. Navy, succeeded some years ago in finding this substance in place as a vein material at a point known as Jade Mountain. Thus was disproved the hotly contested theory that jade existed only in Asia, and hence that all the material, whether found in ancient Roman graves, in France, in the Swiss lakes, or in America, must have been brought by migration or by trade from that continent.

Fine agates were shown from Oregon.

A mineral exhibited and closely similar in appearance to jade is that named by the writer californite, a variety of compact green vesuvianite from Yreka, Siskiyou County, Cal., a stone almost as tough and as beautiful as the best jade, for which it was at first mistaken. Other ornamental stones from California were blue chalcedony (sapphirine) from Kern County, and chrysoprase from Visalia, Tulare County. A notable exhibit was that of the great crystals and masses of transparent quartz obtained some years since in Calaveras County, Cal., from which were cut, as shown in the case, rock crystal balls measuring from $2\frac{3}{8}$ to $5\frac{7}{8}$ inches in diameter.

Southern California, as has already been noted, is fast becoming known as one of the most remarkable gem regions in the world, rivaling the long celebrated treasure ground of the Ural Mountains. San Diego County, with its wonderful yield of gems, was more fully represented than any other part of the coast, notably in the splendid tourmalines from Mesa Grande and Pala—red, green, yellow, and bicolored crystals weighing several pounds, cut gems

weighing up to 30 carats each, and sometimes single stones showing two or three distinct colors. The new gem mineral, kunzite, had the best display yet shown at any exposition. Another recent discovery in gem stones was shown in the fine topaz crystals of light-blue color from Ramona and Valley Center, San Diego County, the best topazes that this continent has produced. The beryls from the same region are also very interesting, one of the rarest varieties being pink beryl, found both at Pala and Mesa Grande. All these minerals were reviewed in the report of this Bureau for 1904, in the section on the gem minerals of California.[a] The special exhibit made by San Diego County attracted much attention and received a first-class gold medal.

As to the neighboring western States and Territories, a rich display was made from Arizona of the beautiful malachite and azurite specimens from the copper mines at Bisbee, Clifton, and Morenci; also of the elegant chrysocolla, coated with transparent crystals of quartz, from the Globe mine. Fine examples were shown of peridot (chrysolite) from the lately discovered locality for this mineral at Talklai, Ariz., one of these being a cut stone of 25¾ carats. Turquoise matrix, from Gila County, is a somewhat novel ornamental stone, the rock, traversed by small veins of turquoise, being cut and polished so as to produce a pleasing effect. Another ornamental stone, representing lapis lazuli and like that celebrated mineral adapted to choice uses in art work, is dark blue fibrous dumortierite from Clip, Yuma County, Ariz.

New Mexico was represented by specimens of turquoise and of the pyrope garnets from the Navajo nation, which are often miscalled rubies.

From Utah was shown the elegant green mineral utahlite, from the Floyd mining district in Clay Canyon. This substance is found only in Utah.

Wyoming was represented by fine pieces of moss agate in large polished slabs, from Hartville.

Among the most valuable gem materials shown from Montana were the beautiful blue sapphires from Yogo Gulch, Fergus County, which present a striking contrast to the varied colors of the sapphires found in the placer washings near Phillipsburg, Granite County. These latter are all obtained by sluicing, whereas in Fergus County sapphire is mined in solid igneous rock. Montana was also represented by some remarkable examples of amethyst and of smoky quartz found a few years ago in the Little Pipestone district, in Jefferson County.

The cut stones in the exhibit numbered altogether 90, and the uncut specimens 129, a total of 219.

Gem gathering in Ceylon.—Mr. A. K. Coomeraswamy, director of the mineralogical survey of Ceylon, has published a paper on the rocks and minerals of that island,[b] with special reference to the gems that have been gathered there from time immemorial. In the Report of the Mineralogical Survey for 1904[c] an extended account is given by Mr. Coomeraswamy and the assistant director, Mr. James Parsons, on the "gemming" industry of Ceylon. The gems of the island are all obtained from a widely distributed gravel or *illam*, with the exception of some garnets and the valuable Ceylonese moonstone, which latter is taken out by quarrying from an adularia-bearing leptynite, in the central Province. The gravels are now worked by washing in the Ratnapura district of Sabaramamuwa Province and in parts of the southern Province. Elsewhere they appear to have been exhausted, and the same fate is steadily approaching the regions that are still productive.

[a] Mineral Resources U. S. for 1904, U. S. Geol. Survey, 1905, pp. 961–985.
[b] Coomeraswamy, A. K., The Rocks and Minerals of Ceylon: Spolia Zeylanica, vol. 11, pt. 9, 1905, pp. 50–66.
[c] Administration Reports, 1904, Min. Surv., Ceylon, pp. E–11, E–19.

The gems found are corundum, spinel, zircon, iolite, topaz, tourmaline, beryl, and chrysoberyl, the latter in the varieties alexandrite and cat's-eye. The report goes into full details of the localities, the variations in the character, and the situation of the *illam*, the methods of working, etc., and is accompanied by two maps.

Precious stones in India.—Although India has long been associated traditionally with gems and gem production, it yields at present but a small part of the world's supply of such minerals. It is curious to find the statement made by the director of the Indian Geological Survey, Dr. T. H. Holland, in a recent report,[a] that all the gems produced in that country "do not approach in value the unset stones and pearls imported," which, during the period covered by his review (1898–1903), had an average value of over half a million of pounds sterling per year.

In this review a special section is given to gems, of which by far the most important are the rubies of Burma. The diamond occurrences are described almost exactly as given by Mr. Sarratt C. Rudra, and cited in the report of this Bureau for 1903.[b]

For the rest, a few notes are added here: The blue sapphires formerly obtained in the Kashmir State appear to have been exhausted of late, and no records are procurable.

Ruby spinel is a common associate of the true ruby in Burma both in the gravels and in the limestone rock, and is often mistaken for it.

Another Burma gem stone is the red tourmaline (rubellite), and some attempts have been made to work it, as it is of fine quality. The data of production, however, are very variable and imperfect. The value of the output was estimated at £1,240 in 1900, but was barely £200 in 1903.

There is considerable garnet production in Jaipur, in the mica schists of Rajmahal; also near Sarwar in the adjacent State of Kishengarh. Data from the former are not procurable, but the output from the latter varies widely, its value ranging from £2,000 to £10,000 per year.

Methods of rock and fossil section cutting.—A remarkable piece of work has lately been accomplished in the cutting of large and very thin sections of silicified cycads, by Mr. R. G. Wieland, of Yale University. This work, and the studies which it was designed to illustrate, are presented in a bulletin illustrated by 12 heliotype plates about to be issued by the Carnegie Institution.[c] The material consisted of the cycadaceous trunks of Jurassic and Cretaceous age, which have been found in some abundance within recent years in Maryland, Dakota, and Wyoming. Among the latter, especially, the details of structure are preserved in great perfection in the silicified mass, and it has been possible by this most careful and skillful piece of work to illustrate accurately the peculiar features of these fossils. The sections measure from 10 to 12 centimeters in length and from 6 to 10 centimeters in width. They are cut to the fineness of one-tenth to one-fifth of a millimeter, and polished on both sides and mounted on glass plates on balsam. Mr. Wieland believes that with time for the devising of further appliances, it will be possible to cut thin sections even from entire trunks.

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[a] Rec. Geol. Surv. India, vol. 32, pt. 1, 1905.
[b] Mineral Resources U. S. for 1903, p. 920; also Trans. Am. Inst. Min. Eng., New York Meeting, October, 1903, pp. 11–15.
[c] On the methods of section cutting.

PRODUCTION.

In the following table is given a statement of the production of precious stones in the United States from 1898 to 1905, inclusive:

Production of precious stones in the United States, 1898–1905.

Precious stone.	1899.	1900.	1901.	1902.	1903.	1904.	1905.
Diamond	$300	$150	$100	None.	$50	None.	None.
Sapphire	68,000	75,000	90,000	$115,000	100,000	$100,000	$125,000
Ruby	3,000	3,000	500	None	None.	None.	None.
Topaz	None.	None.	None.	None.	200	None.	500
Beryl (aquamarine, etc.)	4,000	11,000	5,000	4,000	4,000	5,000	6,000
Beryl (pink)					200	100	1,000
Emerald	50	1,000	1,000	1,000	250	None.	None.
Phenacite	None.	None.	None.	None.	None.	None.	None.
Tourmaline	2,000	3,500	15,000	30,000	45,000	40,000	50,000
Peridot	500	500	500	500	5,000	5,000	10,000
Kunzite						10,000	5,000
Quartz, crystal	12,000	10,000	10,000	12,000	10,000	10,000	10,000
Smoky quartz	None.	1,000	1,000	2,000	1,500	2,000	3,000
Rose quartz	100	100	150	200	1,500	1,000	1,000
Amethyst	250	500	500	2,000	3,000	3,000	2,000
Prase	None.	None.	None.	None.	None.	None.	None.
Gold quartz	500	2,000	2,000	3,000	3,000	5,000	5,000
Rutilated quartz	50	50	50	100	100	None.	None.
Dumortierite in quartz	None.	None.	None.	None.	None.	None.	100
Tourmalinated quartz	None.	None.	1,000	None.	None.	None.	None.
Agate	1,000	1,000	1,000	1,000	2,000	2,000	2,000
Moss agate	1,000	1,000	500	500	1,400	1,500	1,500
Chrysoprase	100	100	1,500	5,000	1,500	6,000	5,000
Silicified wood (silicified and opalized)	3,000	6,000	7,000	7,000	5,000	5,000	5,000
Opal	None.	None.	None.	150	200	None.	None.
Garnet (almandite)	5,000	500	100	None.	None.	None.	None.
Rhodolite	None.	20,000	21,000	1,500	1,000	None.	None.
Garnet (pyrope)	2,000	1,000	1,000	1,000	2,000	3,000	5,000
Topazolite	None.	None.	None.	None.	None.	None.	None.
Amazon stone	250	250	200	500	400	500	1,000
Oligoclase	20	20	None.	None.	None.	None.	None.
Moonstone	None.	None.	None.	None.	None.	None.	None.
Turquoise	72,000	82,000	118,000	130,000	110,000	100,000	65,000
Utahlite (compact variscite)	100	100	250	None.	100	200	500
Chlorastrolite	3,000	3,000	3,000	4,000	3,000	2,000	3,000
Mesolite (thomsonite, so called)	1,000	1,000	1,000	1,000	500	500	500
Prehnite	50	50	None.	None.	None.	None.	None.
Diopside	None.	None.	None.	None.	None.	None.	None.
Epidote	None.	None.	None.	None.	None.	None.	None.
Pyrite	1,000	2,000	3,000	3,000	3,000	3,000	2,000
Malachite	250	200	100	None.	None.	None.	2,000
Rutile	200	100	None.	None.	None.	None.	None.
Anthracite (ornaments)	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Catlinite (pipestone)	2,000	2,000	2,000	2,000	2,000	2,500	2,000
Fossil coral	50	50	100	None.	None	None.	250
Arrow points	1,000	1,000	500	None.	None.	None.	1,000
Miscellaneous						15,000	10,000
Total	185,770	233,170	289,050	328,450	307,900	324,300	326,350

IMPORTS.

Diamonds.—The diamond imports for the year 1905 amounted to more than the combined imports for the years 1897, 1898, and 1899. Especially noticeable is the fact of the greater importation of the rough material and the greater increase of the diamond-cutting industry in this country, the importation of the rough amounting to more than seven times as much as that of 1897, to almost three times as much as that of 1900, to about 25 per cent more than that for 1902, and to practically the same as for the years 1903 and 1904. The importation of precious stones for the month of December, 1905, was $3,633,379, as much as the importation of any entire year up to 1879.

The following table shows the value of the diamonds and other precious stones imported into the United States from 1901 to 1905, inclusive:

Diamonds and other precious stones imported and entered for consumption in the United States, 1901–1905.

Year.	Diamonds.					Diamonds and other stones, not set.	Total.
	Glaziers'.	Dust.	Rough or uncut.	Set.	Unset.		
1901	$5,864	$831,984	$6,592,469	$2,654	$13,544,326	$1,838,055	$22,815,352
1902	10,738	798,523	8,221,389	175	13,834,168	1,888,793	24,753,586
1903	10,634	720,150	10,275,800	675	13,022,367	2,494,897	26,524,523
1904	73,054	445,621	10,234,587	559	13,439,023	1,893,969	26,086,813
1905	6,851	190,072	10,281,111	741	20,375,304	4,144,434	34,998,513