DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

MINERAL RESOURCES

OF THE

UNITED STATES

CALENDAR YEAR

1902

DAVID T. DAY

CHIEF OF DIVISION OF MINING AND MINERAL RESOURCES

WASHINGTON

GOVERNMENT PRINTING OFFICE

1904

PRECIOUS STONES.

By George F. Kunz.

INTRODUCTION.

Since 1894, when the business of the country was at its lowest ebb, there has been a great advance in the lapidary industry in the United States. The fact that larger establishments have been formed which are able to purchase the rough diamonds in greater quantities, has placed our American diamond cutters in a position quite equal to that held by those of Amsterdam, Antwerp, and Paris. The cutting of our native gems has also proved to be something of an industry, notably in the case of the beryl and the amethyst, found in North Carolina and Connecticut; the turquoise, from New Mexico, Arizona, Nevada, and California; the fine-colored and deep-blue sapphires found in Montana; the colored tourmalines, of San Diego County, Cal.; the chrysoprase, mined at Visalia, Tulare County, Cal.; the garnets of Arizona and New Mexico; and also, notably, the pale-purple garnets from North Carolina.

In addition to the usual work on gems, there has been the greatest demand known in years for fine cutting. Stones already cut abroad have been recut here with sharper angles and a higher polish. The lentil-shaped stones, the marquise, the double marquise, the heart-shaped, and the rose-brilliant stones are shapes that generally indicate the recutting of the gems. This form of lapidary work requires very great skill. The cutting must usually be of such a character as to suit the fancy of the buyer. This fact has led to the establishment in this country of a number of lapidarian works in which all the employees are much more skillful than were those of a decade ago, and their work is of a much higher class than the commercial work of Oldenburg and of other foreign gem-cutting centers.

The total of precious stones imported into the United States for the year 1902 reached the high valuation of $24,753,586, being $1,938,234 more than for the previous year, and nearly nineteen times as great as in the year 1867—showing the enormous advance in wealth and taste that has taken place in this country in the course of a generation.

The production of precious stones in the United States in 1902 was valued at $338,300, as compared with $289,050 in 1901.

DIAMOND.

INDIANA.

In the report of this Bureau for 1900, mention was made of the finding of a diamond of 3¾ carats on a branch of Gold Creek, some 9 miles north of Martinsville, Morgan County, Ind. Reference was also made to the rumor that other smaller diamonds had been found in the same region. Recent information received from Mr. R. L. Royse, of Martinsville, gives a full account of the facts in this matter. The stone above noted was found by an employee of his, from whom he purchased it. A considerable amount of panning for gold has been done in the streams of Brown and Morgan counties for some years by certain old residents, well known as farmers and prospectors. Two of these have found occasional diamonds. Mr. Royse himself possesses six besides the one mentioned, which he sold. Of these, four are from Brown County, purchased from one of the old prospectors who obtained them; three are very small, weighing hardly a carat together; the fourth weighs about 1 carat. In color, the last is a blue-white, the others are tinted—a brown, a yellow, and a bluish one. Another local gold-seeker has a diamond of 2 carats, which he found also in Brown County, making five positively known from that county, to say nothing of others reported, but not actually seen by Mr. Royse. From Morgan County he knows of three, viz., the large stone first announced, found 3 miles west of the village of Centerton; a little one, of ⅛ carat, found by himself in gold-panning; and a third, of ¾ carat, purchased from one of the old prospectors. Most of the stones are clear and flawless. This makes eight in all positively known from these two counties of central Indiana.

As regards the minerals associated with the gold and diamonds of the creeks of this region, the writer received samples from Professor Blatchley, the State geologist of Indiana, which comprised the following species and varieties: Quartz, vein in ironstone; white chalcedonic; rolled pebbles, colorless and clear, also milky; red jasper; iron ores—magnetite, showing some cleavage, with quartz and decomposed muscovite; red hematite, resembling the ore of Marquette; limonite, a rolled pebble; menaccanite; pyrite, small cubes in quartz; marcasite, stalactitic; zinc blende (sphalerite), cleavable, yellow with black spots, in quartz; metallic inclusions, evidently rutile, in corundum, of a pinkish to bluish tint; zircon, broken prisms, yellow and transparent, 4 by 2 mm.; garnet grains (almandite), purplish red; cyanite, blue reflections in green, prism fairly perfect; amphibole, brown, with chatoyant reflections; rocks, gray shale, and putty-like clay. Only the magnetite and menaccanite are at all abundant, and next to these the garnet.

WISCONSIN AND CANADA.

In regard to the source of the diamonds carried south by the Glacial ice sheet and found scattered along the line of the terminal moraine from Wisconsin to Ohio, Mr. Archibald Blue, the Canadian geologist, is disposed to differ from Professor Hobbs as to the distance through which they have been transported.[a] The latter, estimating from the direction of the striæ and the width of what he terms "the fan of distribution," locates the source in the unexplored region of Ungava, east of Hudson Bay. It has already been suggested in the report of this Bureau for 1899[b] that this determination depends on the theory of there being but a single source, or at least on the theory of the sources lying within a very limited area; whereas if there were localities, as in Brazil, extending through or along a considerable region, they need not lie so far to the north. This is essentially the position taken by Mr. Blue. He emphasizes the fact that the bulk of the material forming the terminal moraine and the moraines of recession has been carried only a moderate distance from its source, and although he admits the possibility of Professor Hobbs's view, he is disposed to question it.

In this article he reviews the general facts of the occurrences in the United States, especially those in the glacial drift, and describes also briefly the theories as to the source of the diamonds in Africa. He goes on to say that there has been no search made for diamonds in Ontario, "although Dr. Lawson and Dr. Coleman some time ago suggested[c] that they might be found in the Rainy Lake region." These authors, and Mr. Blue himself, show an evident leaning toward the theory that diamonds are formed by the action of igneous rocks upon strata containing carbonaceous matter, and hence a number of references are made to points in Ontario where rocks of these kinds have been observed in some proximity, as possible sources for the diamonds of the drift. Logan, Macfarlane, Coleman, and Lawson[d] are cited as to ancient volcanoes, numerous dikes and intrusions, and graphitic and carbonaceous slates at various points north of the Great Lakes. Mr. Blue himself emphasizes the vicinity of Thunder Cape, Lake Superior, and of Balfour, near Sudbury, as presenting conditions favoring, or at least suggesting, the production of diamonds in this manner, and he advocates careful investigation at these points.

[a] Blue, Archibald: Are there Diamonds in Ontario?: Bureau of Mines Report (Ontario), 1899, pp. 119-124.

[b] Extract from Mineral Resources U. S. for 1899, U. S. Geol. Survey, 1901, p. 8.

[c] Can. Nat., vol. 4, new series, pp. 461-463.

[d] Geol. Surv. Canada, 1887; Geol. Rainy Lake region, p. 180 F.

BRAZIL.

An exploration company has been formed in London for the purpose of searching for diamonds in the Serra de Frio Mountains in the State of Minas Geraes, the object being to explore the mines, to work them, and to sell diamonds. The report[a] is very elaborate, but no great amount of development is recorded as having been carried on.

Diamonds and carbons in Bahia.—An extended account has lately been given by Mr. H. W. Furniss, United States consul at Bahia, of the occurrence of diamonds and carbons in the State of that name in Brazil.[b] This account is valuable not only in itself, but for comparison with the similar account reviewed in the report of this Bureau for 1899 of the diamond mines of the State of Minas Geraes, by Mr. T. C. Dawson, of the American legation at Rio de Janeiro.

Mr. Furniss outlines briefly the history of the Bahia diamond workings from their reported discovery in 1821 and their first development in 1844, when a rush began for the district. Since that time they have been more or less actively worked. Fourteen mining districts are officially recognized, but Mr. Furniss groups these into two well-marked geographical sections, one in the central part of the state, in the basin of the Paraguaçu River and its tributaries, and the other in the southern part, along the valley of the Pardo River. His experience is almost wholly with the first of these two regions. The latter, which he calls the Cannavieras district, is reached from the port of that name by ascending the Pardo River, and has been known as a diamond region only since 1881. An account of it from other sources will be found in this report further on. Very recently other descriptive articles have appeared—some of them already referred to in reports of this Bureau—which point out the richness of these Bahia districts along the almost unexplored valleys of the numerous affluents of both the Paraguaçu and the Pardo.

The enormous production of diamonds from the African mines, together with the facts that the methods employed in Brazil are crude and unsystematic and that the most accessible places at all profitable under such methods have been much worked over and worked out, have caused a great decline in the Brazil production for some time past. But there is a very wide extent of diamantiferous country awaiting only the introduction of improved processes.

The chief center of production in the first or Paraguaçu River district lies 250 miles or more inland from the city of Bahia; but diamonds begin to be found in the bed of the Paraguaçu about 150 miles from the coast, and from that point up the river to the town of Andarahy, which is one of the mining centers. Their occurrence in the

[a] The Diamond Fields of Brazil, 1902, London, pp. viii, 75.

[b] U. S. Consular Reports, No. 1423, August 20, 1902.

river bed, however, renders them difficult to obtain. The diamantiferous region extends for about 172 miles, with a breadth varying from a maximum of 16 miles to a minimum of 3 or 4. It includes several mountain ranges, the Serra do Sincora, with the headwaters of the Paraguaçu and the Una, the Serra dos Remedios, the Serra das Lavras Diamantinas, the Chapada Velha, and a portion of the Serra do Espinhaço. The most productive region is apparently that of the foothills east of the Serra das Lavras Diamantinas, along the small tributaries of the Paraguaçu.

The geology of the region is described by Mr. Furniss as consisting of granitic hills, with much sandstone and conglomerate. The granite shows a slightly inclined stratification, and hence is probably in strictness a gneiss. This rock is frequently broken by gullies, fissures, or crevasses, which are in many cases filled with the sandstone and conglomerate, and these latter also occupy small basins in the crystalline rock. All are much weathered and in some places disintegrated. The diamonds and carbonados occur in the fragmental rocks, and according to Mr. Furniss, in the granitic also, a fact of much interest, if it shall be clearly established; but they can only be obtained from those portions of either that have been pretty well disintegrated. Much of the work is done in the gullies, fissures, and cavities, which are occupied by soft sandstone and conglomerate; but sometimes these are rendered inaccessible, at least in their lower portions, by hard ledges or by water; and hence promising spots, rich in diamonds, have to be abandoned as unworkable by the rude and simple methods employed.

The river and stream beds are largely occupied by bowlders and gravel, the latter apparently the equivalent of the diamond-bearing formação of Minas Geraes, described in Mr. Dawson's report. The small basins in the gneissic rocks of the hillsides would seem to correspond to his gupiaras. Mr. Furniss describes the digging out of the cascalho, or diamond gravel, and piling it up until the rainy season, and also the conducting of water in some cases through native-made sluices, etc., to wash the cascalho, in ways that correspond closely to those noted by Mr. Dawson. The washing process, first in troughs or ditches, and then in wooden basins (bateas), and the skill acquired in picking over the residue and recognizing diamonds therein, all resemble methods described by Mr. Dawson, and are identical also with those of the South Borneo diamond miners, depicted by M. Gascuel in his recent article.[a]

The method of obtaining the river-bed stones, however, presents a marked difference from that in Minas Geraes. Nothing is said of diverting the stream and excavating its bed during the dry season, as in the valley of the Jequitinhonha, but Mr. Furniss tells of diving as

[a] Production of Precious Stones, extract from Mineral Resources U. S. for 1901, U. S. Geol. Survey, 1902, pp. 17-18.

employed along the Paraguaçu. This is conducted in two ways, the principal one involving the use of what he calls "diving machines," i. e., apparently movable caissons, beneath which two men can work alternately for three hours each, gathering the cascalho into sacks lowered from above. This method is in use along the Paraguaçu from João Amaro, the point where diamonds first appear in the bed, as before noted, nearly up to Andarahy; and there are at least six of these machines engaged during the available season. The other method is pursued by individuals, who dive naked into the shallow parts of the river, especially in the dry season, and bring up what they can gather of the cascalho during a brief submergence.

Mr. Furniss states that the field is not one to attract the fortune seeker, although occasional wealth may be obtained; but the uncertainty is great, hardships are many, food is poor, and climatic conditions are trying and unhealthy.

Some five thousand people are engaged in diamond mining, but irregularly and with no system. The tools are the commonest—a hoe, a crowbar, a stout iron hook on the end of a pole, sometimes a hammer and a hand drill, and two basins for washing—a larger and a smaller. Rarely a little powder is used to blast away some obstructing piece of rock. Through years of such crude exploitation, sand and gravel have been washed down from the small streams to the larger ones, covering up rich river beds with quantities of débris, which will require considerable expenditure of capital to remove. In a tour through the entire district, Mr. Furniss failed to find a single attempt at modern methods. "In the home of the carbon there was not even a hand-power rotary drill, much less a carbon set drill, which would frequently save days of work and much expense." Instead, men with hand drills and hammers make about three holes a day. In many places water comes in faster than it can be bailed out; and such openings have to be abandoned until some methods of pumping can be introduced. The native pumps, described with so much interest by Mr. Dawson, in Minas Geraes, do not seem to be known or used here.

All diamond and carbon lands belong to the State, which maintains a director at the town of Lemçoes. The laws are specific, though liberal, and persons of any nationality may lease claims. The property must be described and applied for in writing; and then, after a prescribed time of announcement, it is offered at auction, the highest bidder obtaining a lease for a period varying from one year to ten, with certain rights of renewal. There is usually but little competition at the sale. Individuals who do not care to lease claims may take out licenses for a fee of $1.50 a year, and must also, each one, pay a local village tax of 10 milreis, about $2.40. Mining without lease or license is subject to confiscation of tools used and stones found, one-half going to the informer. About 350 leased claims are being worked, and "it is estimated that there are 450 other productive claims without lease."

Besides these leases and licenses, some large concessions have been granted to individuals and companies, almost all Brazilian, save a French company at Cannavieras. These and the ordinary lease-holders generally work their mines on shares rather than by fixed wages, the miners paying the lessees one-fourth or one-fifth of the diamonds and carbons obtained.

This method is found more profitable, as the miners work better on their own account than for a fixed wage. There is little chance for cheating, as the buyers know all the parties concerned and reserve the proper share for the owner when purchasing.

Mr. Furniss refers to the recent high price of carbons and to the statement frequently made that it is maintained by a syndicate or combination. He finds no ground, after full inquiry, for the idea of any such combination among the miners, the buyers in the field, or the exporters at Bahia. He gives a full account of the manner of purchasing by field buyers representing five principal firms in Bahia, all being kept systematically informed as to market rates, which are determined by values in Europe constantly cabled to Brazil. The field buyers work independently, and there is even more or less competition for any particularly good material. The miners obtain prices that are a fair equivalent according to the rates abroad and the fluctuations of the Brazilian currency.

The great increase in prices for carbons is illustrated by some figures given in the report. To cite only in part: In 1894 carbons were bought in the field from the miners at from $4 to $4.40 per carat; in 1898 the rate paid was $11 to $11.20. The cause of the higher prices lies principally in the vastly increased demand for carbons in mining and drilling machinery, with the fact that while the supply in existence is immense, it is practically limited by the defective methods of working. The present output averages 2,500 carats a month; but, without more capital and improved methods, Mr. Furniss thinks it can not maintain even this rate; and the demand is steadily growing. Water power is abundant, "and with electrically run drills, pumps, and other machinery, there is fabulous wealth awaiting development."

Two grades of carbons are recognized—good, and porous or crystalline. Present prices for the best grade range from $24 a carat for stones over three-fourths of a carat in weight down to $7.20 for those between three-fourths and one-half a carat, and to about $2.75 for smaller ones, which last are mixed with imperfect and refuse diamonds. The porous and crystalline grade of carbons sell for about half of the above-noted rates. The average size of the stones found is about 6 carats in weight. Stones between 1 and 2 carats are the most desirable, as they do not require to be broken up for commercial use. Very large specimens command a relatively lower price, on account of the labor and cost of breaking them up. Two enormous pieces have been found within a few years past, upon claims belonging to the same lessee, who received in both cases one-fourth of the first selling price. The first was the unique and celebrated mass, weighing 3,150 carats, found in 1895, and briefly mentioned in the report of this Bureau for that year;[a] the other was discovered in 1901, and weighed 750 carats. The prices paid for these two remarkable stones furnish a striking illustration of the advance in values during the interval of six years. The amount paid the finder was, for the second, $17,380, although the first (five and a half times as large) had brought but $16,000. The first mass went through several hands, and was purchased in Bahia for 121,000 milreis, about $25,400; it was then sent abroad and finally broken up, not in Paris, as stated in Mr. Furniss's article, but in London, as described in the paragraphs following this abstract. The other mass is also described in this report farther on. Another immense carbon, of 975 carats, was mentioned by Mr. Furniss in his former article, as found in 1894,[b] but he does not refer to it here. It is said to have brought $19,300 in Paris, where it was finally broken up, but it failed to realize anything like that sum when sold in pieces.

The diamonds of the Paraguaçu country are stated to be more brilliant than those of the Cannavieras region but less perfect and clear; they occur with the carbons, and are often impaired by black inclusions. The field buyers divide them into five grades: Bons, those of good shape and color; fazenda fina, small and tinted stones, but otherwise fine; mellé, off-colored and imperfect; vitriar, very small, bright stones of various colors; and fundos, defective and broken stones, unfit for jewelry, and mixed as above noted, with second quality carbons. The prices paid in the field vary somewhat, but average for first grade $11.50 per carat; for the second, $10.50; for the third, $5, and for the fifth, $2.50. The fourth class, the brilliant little vitriars, are sold by the quarter carat, which contains from six to eight stones, for 12 milreis ($2.88), about the same rate as the bons. The other grades are usually bought by the oitava, 17½ carats. To these prices must be added transportation to Bahia by special carriers and the Bahia dealers' profit for the prices in that city; and for stones reaching Europe, the export duty (13 per cent), the steamer charge, and insurance must also be added.

The stones are mostly small, averaging about 1 carat. In a lot of nearly a thousand carats' weight of stones examined by Mr. Furniss the largest weighed 3½ carats. About 30 per cent were of the poor

[a] Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 3 (cont.), p. 903.
[b] Twentieth Ann. Rept. U. S. Geol. Survey, pt. 6 (cont.), 1899, p. 567.

LARGEST PIECE OF CARBON EVER FOUND. ACTUAL SIZE.

grade, fundos; the rest were good to fair. Other lots gave like results, and these are probably average examples.

The actual output is hard to estimate. The only data are the export figures, and these are far below the reality, as the amount thus indicated for both diamonds and carbons is less than the value of the latter alone. This shows that large quantities must leave the country without paying duty. All the shipments are to Paris and London.

The diamonds are exported uncut, though there are several cutting establishments in the diamond region and one in Bahia. But there is at present little demand for cut stones in the country, a condition different from that reported in Minas Geraes by Mr. Dawson in 1899, but perhaps due to financial depression, as Mr. Furniss believes.

The carbons are sold in mixed lots, and all sorting is done in Europe. So long as this method is maintained, American dealers will continue to purchase abroad, at higher cost, rather than in Brazil, where they can not obtain selected material, and must take all sorts and sizes of carbons together.

A recent article in Le Diamant, of Paris, refers to this same subject of the difference between miscellaneous and selected carbons, and states that in London, which is the principal market, the dealers sell unsorted lots, which are of little use to the engineer or the factory superintendent, who needs certain sizes and qualities; that Germany has lately recognized this fact, and that consequently the Berlin dealers are developing a profitable business in assorted carbons.

With regard to the great carbon masses, although only two are usually spoken of, there seem really to be three on record: (1) The one of 975 carats found in 1894, which was broken up in Paris and sold at less than its cost, $19,300, as stated by Mr. Furniss in his former article[a] referred to above. (2) The greatest piece, found in 1895, shown in Pl. II, natural size. As to this carbon, a recent letter to the Journal of the Society of Arts[b] and a subsequent one to the writer from J. K. Gulland, esq., of London, furnish precise details. He says: "It was not broken up in Paris; I broke it up here myself. The exact weight was 3,078 carats. I bought the stone on September 19, 1895, for £6,464 (about $32,000), broke it up into pieces suitable for use in diamond drills, and resold the whole at 10 per cent profit. * * * Now, it would be worth £26,163 (about $130,815). The present price of carbon at the mines (November 17, 1902) * * * is £8 10s. to £9 per carat," for good quality. (3) The third, though usually spoken of as the second, is the mass found in 1901. This was taken abroad and exhibited at the Düsseldorf Exposition of the same year. It is here shown in the accompanying illustrations, Pls. III and IV. These and the following notes are from the Organ des

[a] Twentieth Ann. Rept. U. S. Geol. Survey, pt. 6 (cont.), 1899, p. 567.
[b] Journal of the Society of Arts, 1902.

Vereins der Bohrtechniker,[a] Vienna, of April 15, 1902, to which the data were furnished by Messrs Joh. Urbanek & Cie., of Frankfurt-am-Main. The stone as a whole weighed 750½ carats; the single pieces into which it was divided weighed from 3 to 4 carats each. Besides its extraordinary size, its quality was remarkably fine, and hence the division was very successful, especially with regard to the beautiful surfaces of the separated pieces. The division itself of such a stone is a very peculiar task, and requires long experience to achieve a successful result. Moreover, the artisan, in order to complete the work properly, must needs forget that he is handling a stone worth 100,000 marks ($23,600). Carbons vary much in hardness, and they can not stand a heavy blow or exposure to great heat; a hard blow will often crush the stone to fragments, and a great heat may destroy its quality. Of great interest is the statement that some samples of carbon used in a boring drill were changed, in consequence of the stopping of the water current, to a black mass resembling glass (perhaps a graphitic material), and so soft as to be easily affected by a file, while the soft iron of the borer was hardened to steel. Ilmenite, nigrine, and other black minerals are often mistaken for carbon, but they naturally fall to pieces the moment the pressure of the drill is applied to them.

BRITISH GUIANA.

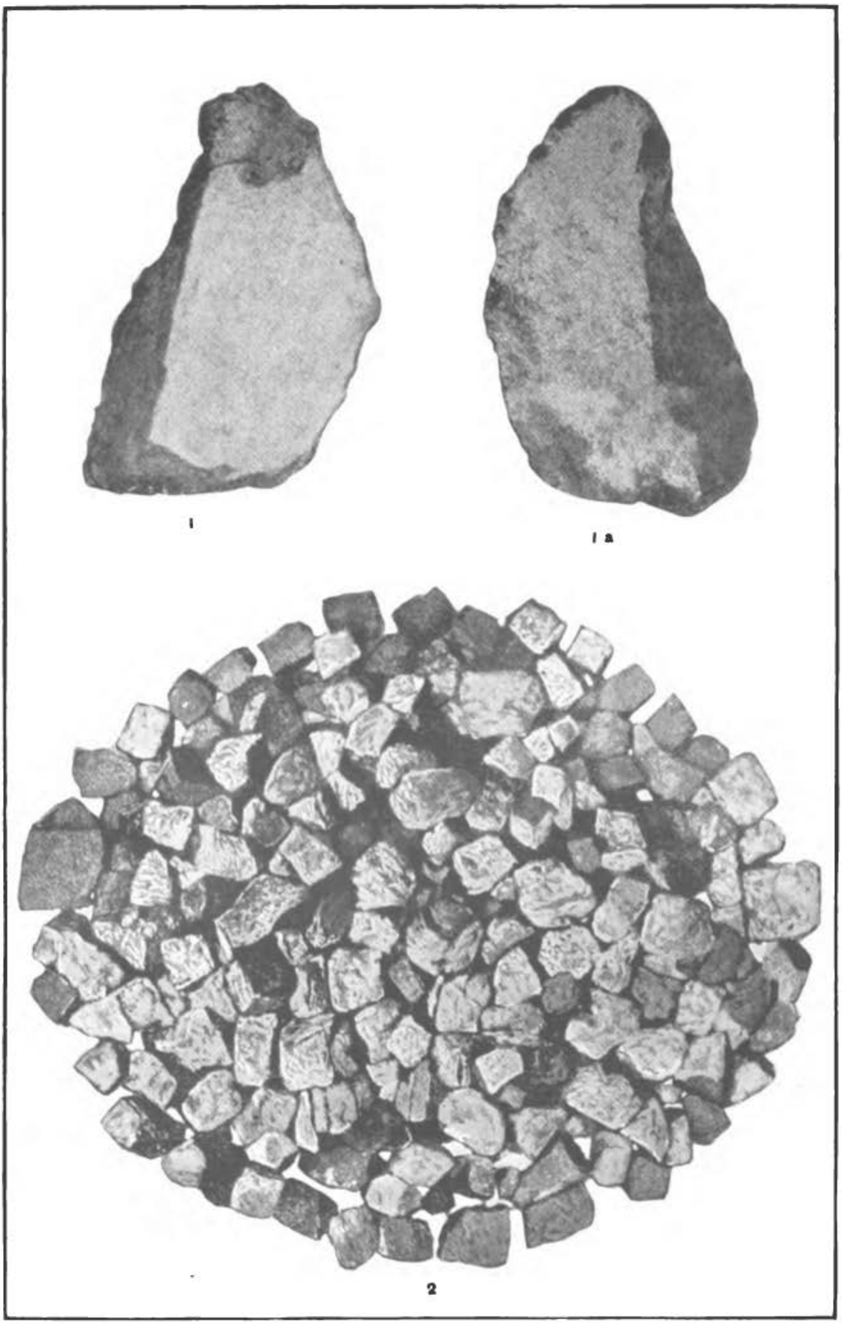
Further data have appeared as to the diamond discoveries in the Upper Mazaruni Valley in British Guiana,[b] in the Thirteenth Annual Report of the Institute of Mines and Forests of British Guiana on the gold, diamond, and forest interests of the colony for 1901–2.[c] About one page is given to the diamond industry, and the facts may be summed up as follows: In the year ending June 30, 1902, the number of diamonds "declared" was 132,077, nearly all from the Mazaruni district, though 1,414 stones came from the Potaro, and a very few from other districts. These occurrences are noted as indicating a somewhat wide distribution of the diamond-bearing deposits. Of late, stones of somewhat larger size have been found, though most of the Guiana stones are quite small. They are spoken of as closely similar to those from Diamantina, Brazil, and the suggestion is made that careful and extensive search may develop the presence of deep deposits, such as some of those in Minas Geraes.

Machinery is being introduced, and good results are looked for, although, as in previous years, the remoteness of the Upper Mazaruni Valley and the difficulties of transportation are still great obstacles to successful progress. On the other hand, these conditions prevent a

[a] Organ des Vereins der Bohrtechniker, 1902, Wien, April 15.

[b] Mineral Resources U. S., 1901, U. S. Geol. Survey, 1902, p. 735.

[c] Thirteenth Ann. Rept. Institute Mines and Forests of British Guiana, Georgetown, 1902, p. 15.



THE CARBON SHOWN IN PLATE III, AS FINALLY BROKEN INTO PIECES FOR DRILLS.

1, 1 a, Inner sides of upper part of the carbon shown on Plate III, fig. 2; 2, the entire third largest piece of carbon broken into pieces that weigh from three to four carats each, the sizes generally used for diamond drills.

rush of the undesirable element that has greatly impeded operations at some of the gold mines, and thus there is a compensation.

Plans are under consideration by the Colonial Government for opening a road from the terminus of steam navigation at Potaro to the still water above the Mazaruni falls, which is already traversed by a steam launch. Another proposal is for a light steam or electric railroad extending the Caburi road, which has been built for some distance above Bartica. This is in the line of United States Consul Moulton's suggestion referred to in the last report of this Bureau.

No less than twenty-seven companies are engaged in mining, and have "declared" diamonds during the year; but only fourteen of these have reported over 100 stones. The greater part of the production has been by Messrs. Armeny & Fogel, 55,608 stones; the British Guiana Company, Limited, 27,557; the Mazaruni Company, Limited, 26,280, and the Marshall Syndicate, 14,045. The customs returns show an export for the year covered, of 9,822½ carats; if the bulk of the stones obtained have been exported, their size would appear to average only about one-third of a carat. No data are given as to this point.

The following are the returns supplied by the British Guiana[a] Department of Mines as to diamonds and other precious stones (evidently nearly all diamonds) produced during the past year, showing the monthly output:

Production of diamonds and precious stones in British Guiana in 1902, by months.

Month.	Number.	Weight.
		Carats.
January	11,253	1,098¼
February	12,403	1,176⅛
March	14,020	1,261½
April	22,914	1,516 13/16
May	10,474	753
June	21,042	1,047
July	5,562	381
August	24,876	1,358 5/16
September	10,337	517¾
October	15,680	754 1/16
November	13,870	901⅞
December	10,413	951 13/16
Total	172,844	11,718¾

It thus appears that the 172,844 diamonds give an average of nearly 15 stones to the carat.

INDIA.

The Mining Journal (London) for February 28, 1903, has accounts from its correspondents as to gem mining in India. Although that

[a] The Mining Journal (London), February 7, 1903.

country has been so long renowned in history and tradition as the source of gems, little is now being done, save the ruby mining in Burma. The diamond industry is practically dead. Work is still carried on by the Madras Diamond Company, at Vajrakarur, but no output is reported for 1902. In the alluvial mines of the Bundelkund, in central India, the last returns were of 169 carats, in 1900.

BORNEO.

Diamonds have long been known to exist in southwestern Borneo, in the region of the Landak River near the mouth of the Seran River. A piece of so-called serpentine has been there obtained which incloses a diamond apparently in its true matrix. The Rajahs of Panembohan and Pongerans possess an immense belt studded with diamonds, said to be from this district, one stone weighing 67 carats. It is a peculiar belief of the natives that the gold and diamonds in the earth are a sort of bank, and should be worked only when they themselves need money, since they believe that gold and diamonds are always there when they desire them. The great Borneo diamond of Mattam, said to weigh 367 carats, is believed to be from this same region. During the last year the entire district has been examined by competent engineers, and an effort is now being made to exploit it systematically.

In the last report[a] of this Bureau an abstract was given of the account by M. Gascuel of the diamond region of southeastern Borneo. [In this abstract the word "northern" occurs in two places for "southern" by an error noticed too late for correction.] The account dealt principally with the Bandjoe-Irang district and the valley of the Martapoera, an affluent of the Barito, but mentions other less-known districts in the same portion of the island. A recent article, referred to in the Geologisches Centralblatt,[b] and taken from the Dutch of H. E. D. Engelhardt,[c] on the Doessonlaender district of southeastern Borneo, mentions the occurrence of diamonds and gold along the tributaries of the Barito, especially on the Mewien and the Djoeloei, left and right branches, respectively, of that stream.

NEW SOUTH WALES.

Mr. George W. Card, F. G. S., curator and mineralogist of the Geological Survey of New South Wales, has recently described very fully the eclogite-bearing breccia from the Bingera diamond field,[d] which is of so much interest in its relation to the occurrence of the same rare rock in the "blue ground" of the African diamond mines. This

[a] Production of Precious Stones, extract from Mineral Resources U. S. for 1901, U. S. Geol. Survey, 1902, pp. 13-19.

[b] Geol. Centralblatt, vol. 2, No. 23, p. 793, December 1, 1902, Leipzig.

[c] Bijdragen tot d. Taal-, Land-, en Volkenkunde v. Ned. Indie, 6 Volgreeks, 8, d. (D. LII.), 1901, pp. 179-222, s'Gravenhage Mart Nijhoff.

[d] Records of the Geological Survey of New South Wales, vol. 7, pt. 2, 1902, pp. 29-39, Pls. IX-XI.

peculiar breccia has a close resemblance to the diamond-bearing rock at Kimberley, and like it, occupies a vertical "pipe" or chimney, piercing through sedimentary beds, and is itself traversed by basaltic dikes. The locality is at Ruby Hill, 12 miles south of Bingera, and has been described by the Government geologist, Mr. E. F. Pittman, in the Mineral Resources of New South Wales.[a] The occurrence of diamonds in this eclogite breccia, or at least in very close association with it, and the recent recognition of the same fact in South Africa, give it extreme interest. The eclogite occurs in bowlders and fragments in the intruded basalt and largely in the breccia, from which Mr. Card thinks that it may have been taken up by the basalt. The breccia consists of pieces, large and small, of melaphyre, claystone, and eclogite, embedded in a granular mass composed largely of minerals liberated by the decomposition of the latter. The masses of eclogite are seen to be altering from without into the greenish earthy mass of the decomposing breccia. Of the liberated minerals, pyrope garnet is the most abundant, then a green pyroxene, a little feldspar, occasional quartz, pleonaste, zircon, and perhaps cyanite. There is much secondary calcite and some magnetite. The whole is singularly like the African mixture.

Mr. Card goes into a detailed discussion of the modes of occurrence of all the components both of the eclogite itself and of the basalt and the breccia containing it, and also of their processes and products of alteration, illustrated with plates of microscopic sections. The paper is one of great interest both as a study of alterations in a rare rock and in connection with the recent views of Professors Bonney and Crookes on an eclogite source for the Kimberley diamonds.

Within the last few years quite extended discoveries of diamonds have been made in New South Wales, and considerable work has been done by individuals and by companies. But the diamonds, though brilliant and remarkably hard, are all small, and the Australian yield can not therefore become of great importance. The modes of occurrence, however, are interesting. The mining region is somewhat extensive, and there are half a dozen principal centers or "fields" located in the northern central part of New South Wales, chiefly in the counties of Hardinge and Murchison, a little north of south latitude 30, and in about longitude 151 east.

In most of these fields the occurrence is much like that familiar in California, in old river gravels which have been covered and protected from erosion by flows of Tertiary basalt. The diamonds are scattered more or less abundantly through these old gravel beds, with gold, stream tin, and various minerals often found in such associations; and occasionally the gravel is cemented by iron oxide into a sort of conglomerate, recalling the Brazilian cascalho; but there is no indication

[a] Mineral Resources of New South Wales for 1901, pp. 292–295.

of the original source. At one or two points, however, they have recently been traced to outcrops of a volcanic breccia, closely resembling the African. This is the case at the Ruby Hill mine, about 12 miles south of Bingera, and is also reported at the Mittagong mine, though the latter has not been much investigated.[a] As in Africa, dikes of basalt are found traversing the breccia. The point of especial interest, however, is the fact that in the breccia, and also in the dikes, occur pieces and irregular masses of the same rare and hard rock, eclogite, above referred to in connection with the latest phases of the discussion as to the source of the African diamonds. It does not appear that any diamonds have yet been detected in this material itself; but its presence under similar circumstances is of great interest, and gives hope of light being shed on the whole question by fuller and further investigation.

QUEENSLAND.

The diamond discoveries in New South Wales have been repeatedly noted in former reports of this Bureau, but no diamonds have been found in the adjoining province of Queensland until quite recently, when a single crystal has been obtained and a few others are reported.[b] The stone was found in the "sapphire wash" of the Anakie sapphire district, elsewhere described in this report (p. 35), at a point in its eastern portion a little south of Policeman Creek. The sapphire miners have been in the habit of mixing a few pale and off-colored stones in the lots that they sold, and an investigation as to this was undertaken by the Queensland Geological Survey. The diamond, unrecognized and taken for a white sapphire, was found among a group of such off-colored stones shown to Mr. Dunstan of the survey, by Mr. McCrystal, who operates the claim where it was found. He thinks that other similar stones have been sent away by the miners as of little value. The diamond is a crystal of 1¼ carats, flawless and colorless, and in form is an octahedron, with faces of the trisoctahedron and hexoctahedron. It was found at the bottom of the layer of sapphire wash, which was clayey and full of bowlders, and which contained also blue and green sapphires, corundum, pleonaste, zircon, and quartz pebbles. The sapphires are believed to have come from a basalt, which spread over much of the region in Tertiary time, but is now largely decomposed, save as it forms the capping of some scattered high hills. The country rock beneath consists of very ancient schists and granites. Nothing can be judged as to the source of the diamond as yet, and it seems pretty clear that there is no frequent or important diamond occurrence in this region.

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[a] Pittman, Mineral Resources New South Wales, 1901, pp. 392–395.

[b] Dunstan, B., Report on the Sapphire Fields of Anakie: Queensland Geol. Survey, Brisbane, 1902, p. 19, and Pl. II, fig. 10.

SIBERIA.

Two small diamonds have lately been obtained from new localities in Siberia, in the alluvial gold mines of northern Taiga, department of Yenisei. The first was discovered in 1897 in the gold mine of Baladin, on the Melnitschnaia, a tributary of the Pit River, itself a right-hand affluent of the Yenisei.[a] The second has been described in two or three articles by P. Jeremejev[b] and L. Jascewski,[c] with some dispute as to the precise locality, but it is from one of the gold mines of the same neighborhood. This is a colorless, transparent crystal, flattened in form and twinned in structure, weighing but 0.13 gram. Its crystallography is given in detail by Jascewski in his article.

An "Index of Minerals which occur in the Mining Districts of the Ural Mountains" has been published by W. P. Yarkov.[d] In this paper diamonds are mentioned as found in the mine of the Chariton Mining Company on the river Dankowka (a tributary of the Serebrianaja), about 3 miles from the Serebrjanovski factory, and at the Nikolai-Swjatitelski mine on the river Issa (district of Goro-Blagodad). Their occurrence is not described, but it is presumable that they are found in connection with gold placers; and as nothing is said of their size or frequency, they are doubtless small and rare. Microscopic diamonds were also recognized as long ago as 1871 by Prof. P. W. Jeremejev, from the Schischim Mountain, near the Kusinski works (district of Zlatoust), but their interest is purely scientific and in no wise practical.

As to the finding of diamonds in the Ural region, moreover, a recent article by N. Wyssotzky on the gold mines of the Kotschkar district,[e] mentions them as sometimes occurring with gold in the sands, together with topaz, beryl, chrysoberyl, euclase, chrysolite, garnet, tourmaline, cyanite, rutile, corundum, and smoky and amethystine quartz.

The occurrence of the diamond in the Ural country was for a long time questioned, but at various times for seventy years past small diamonds have been found in or in close proximity to the platinum and gold washings of the Ural Mountains. Some two hundred stones have been obtained hereabouts, but all of small size. A description of these occurrences has been given by the writer in the Journal of the Franklin Institute.[f]

In a collection at Nijni-Tagilsk the writer saw a small white crystal weighing one-third of a carat, a twinned hexoctahedron, which was pronounced phenacite by a local mineralogist, who had taken its spe-

[a] Glinka, Verh. Russ. min. Ges. St. Petersburg, (2), vol. 35, 1897, Prot., p. 75.

[b] Bull. Acad. Sci. St.-Pétersbourg, (5), vol. 9, 1898, Prot., pp. xiv, xv; Russ. Auszug in: Verh. Russ. min. Ges. (2), vol. 36, 1899, Prot., p. 34.

[c] Verh. Russ. min. Ges., (2), vol. 36, 1899, Prot., pp. 42, 43.

[d] Bull. Ural Soc. Nat. Sci., Ekaterinbourg, vol. 22, 1901, pp. 26–36.

[e] Centralblatt für Mineralogie, Geologie und Paleontologie, No. 11, 1902, Stuttgart, pp. 345–346.

[f] Jour. Franklin Inst., 1898, p. 23.

cific gravity, but which the writer identified as a small opalescent white diamond, similar to those from the Bagagem mines in Brazil. It was found in a small brook near the village of Kalstchi.[a] The existence of pyrope garnets here and their frequent finding seem to favor the theory of the presence of diamonds, although some of the Russians believe that the man who found the diamonds for Humboldt had really deceived him. The pyropes, however, are frequently associated with diamonds, and to a certain extent would suggest their occurrence.

The California diamond district in Trinity and Del Norte counties—the Del Norte-Smith River occurrence—presents a resemblance to this Ural region in the great frequency of platiniferous and chromiferous gold sands in upper California, Oregon, and northward, which would suggest the advisability of further search for diamonds. Very minute diamonds have been found in these sands, but it is possible that larger ones may be encountered. In this connection it is well to recall Prof. J. F. Kemp's statement that "minerals associated with the platinum nuggets are the familiar ones which have been so frequently studied in connection with the much more abundant gold-bearing placers. The commonest ones are gold, silver, copper, iridosmine, and other members of the platinum group—chromite, magnetite, menaccanite, garnet, zircon, rutile, small diamonds, topaz, quartz, cassiterite, pyrite, and epidote. Almost any mineral of high specific gravity which is commonly met in rocks may be expected to appear in the pannings."[b] Hence it is advisable to look for the heavier gem minerals, including the diamond, in the tailings of platinum washings.

NOTE.—With regard to the discovery of a single diamond in Bohemia, in connection with the pyrope garnets at Dlaschowitz, see under Pyrope, Bohemia and Saxony, p. 838.

[a] Jour. Franklin Inst., September, 1898, pp. 23-24.
[b] Bull. U. S. Geol. Survey No. 193, 1902, p. 26.

CORUNDUM GEMS.

SAPPHIRE.

MONTANA.

The sapphire locality on Cottonwood Creek, Montana, noticed in the report of this Bureau for 1896,[a] has recently been investigated by Mr. J. M. Jamieson, and in June, 1902, he discovered, at the head of the main fork of Dry Cottonwood Creek, the source from which the sapphires of that locality were derived. He does not state the character of the rock, which is doubtless an igneous dike, but says that it is a ledge some 200 feet wide, traceable for 3,000 feet, and contains sapphires and garnets. Little development has yet been made, the deepest cut being about 8 feet, but Mr. Jamieson proposes to exploit the locality further very soon. He states that sapphires were found in the bed of the creek about thirteen years ago (1889), but that the ground along the creek was too flat for placer mining. Interest was revived, however, and some little work done, when the other Montana localities, at Yogo Gulch and Rock Creek, began to attract notice. Nothing important has thus far been done on Dry Cottonwood Creek.

QUEENSLAND.

The occurrence of sapphire-bearing deposits in Queensland has been known for over twenty years, but only lately have they begun to attract attention. A report was published concerning them in 1892, by Dr. R. L. Jack,[b] and an extended account has recently appeared, by Mr. B. Dunstan, assistant Government geologist of Queensland.[c]

The location of these deposits, which are best reached from Anakie station on the Central Railway, is between south latitude 23° and 23° 30′, west of longitude 148° east, and east of the Drummond Range of mountains, which runs a little west of north, leaving the great dividing range of central Australia, that trends north toward Cape York Peninsula, at about latitude 26° and longitude 147°.

The deposits are in an ancient alluvium, and occur chiefly in lines or bands parallel to the present water courses but somewhat above them. These slightly elevated ridges are old stream gravels which present a curious likeness and unlikeness to the ancient gold gravels of California. Like them, they represent former valleys filled by basaltic flows, but, in contrast to them, the gravel consists largely of the decomposed basalt, the matrix of the sapphires, which has been almost completely removed by disintegration and does not form a pro-

[a] Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 5, 1897, p. 22.

[b] Jack, R. L., Report on Sapphire Deposits and Gold and Silver Mines near Withersfield; Brisbane, 1892.

[c] Dunstan, B., The Sapphire Fields of Anakie, 26 pp., with maps and plates; Geol. Survey Queensland, 1902.

tecting cap. The protecting element has been supplied by bowlders and masses of an extremely hard siliceous rock of Cretaceous age that partly filled these valleys prior to the basaltic flow, and this covering, though broken up and strewn along the valleys, has even then so resisted wear as to preserve, between and beneath its broken masses, the sapphire alluvium of the decomposed basalt from entire removal. The miners look upon these bowlders of "billy," as they call it, as a sure sign of sapphires, and even as the source whence they are derived.

The sapphires themselves occur in a variety of crystalline forms, which are illustrated in the plates, and in many shades and hues of color, but not in the deep reds and blues most prized for jewelry. Greens, yellows, and light blues, with much dichroism, are frequent, and many of them are very beautiful. In this variety of delicate and peculiar colors they resemble the sapphires of Rock Creek, Montana.[a] Mr. Dunstan believes if they were more freely announced as Australian stones, and their peculiar features were emphasized as such, that they would soon command interest and acceptance, instead of the doubtful and partial favor that they have thus far had when brought into competition with gems of more conventional color from old and standard localities.

An interesting account is given, illustrated by a peculiar colored plate, as to the influence of strongly marked dichroism on the colors of gems, according to the direction in which the "table" or face is cut. The plate shows the widely different hues obtainable from the same crystal in this manner—a point of extreme importance to the lapidary and gem dealer. He suggests the advantage of a more general use of the dichroscope by those engaged in such business, and figures and describes a simple form of the instrument. This pleochroism is marked in the blue Anakie sapphires, is less so in the green ones, and is not observable in the yellow.

The colors found are carefully described, and Mr. Dunstan proposes the name Oriental peridot, instead of Oriental emerald, for the deeper green stones, and Oriental chrysoberyl for the light yellowish greens. The blues vary much in depth of color, but the real cornflower tint is not found. Red is very rare, and the purple (Oriental amethyst) also, but sometimes very fine.

The sapphire wash is usually a more or less clayey material, with bowlders of basalt and "billy," and is sometimes overlain by more recent alluvium. Many minerals occur with the sapphires, notably pleonaste and zircons, the latter sometimes of gem quality. One diamond was found, elsewhere described in this report. The sapphires are obtained in much the same way as gold, only that sieves are used instead of the pan. The coarser gravel and the fine material are thus removed, either by washing or jigging, according as water is accessible

[a] Mineral Resources U. S. for 1900, U. S. Geol. Survey, 1901.

or not, and the smaller gravel picked over for sapphires by hand. Dr. Jack, in his former report, stated that he obtained from a ton and a half of wash dirt "254 stones of from 3 to 179 carats each, and weighing in all 3,289 carats." This would give nearly 13 carats as the average weight. Mr. Dunstan, however, thinks this much overestimated, and has hardly found even one-half of such results.

Values and statistics are difficult to obtain. From one hundred to two hundred men are working throughout the region, with the fluctuating success of prospectors and pioneers. The gems, too, are variable in value, from not having yet been "standardized," and hence are not like gold, the amount of which obtained by a day's work is at once easily estimated at fixed rates. Mr. Dunstan judges that the amount realized thus far by the miners for stones sent from the Anakie fields may be about £10,000. He regards the prospects for permanent production as being very good. Much of the country is yet unexplored, and new discoveries are constantly being made.

CORUNDUM.

CONNECTICUT.

Corundum with carbon.—A singular occurrence of corundum associated with carbonaceous matter is reported at Barkhamsted, Conn., by Prof. B. K. Emerson, of Amherst College, in the American Journal of Science for September, 1902.[a] The corundum forms a bed between 2 and 3 inches thick, very pure, dark blue or blue-black in color, with occasional patches of pistachio green. It is granular, glistening, and resembles the emery of Ceylon. The specific gravity is 3.64. When magnified it is seen to consist of elongated grains. Through it are scattered small, stout prisms of cyanite, and it is densely penetrated with a coaly substance intimately mingled with the corundum in trains and rounded balls. "This carbonaceous matter," says Professor Emerson, "has been evidently introduced in an oily or tarry condition, and has been inspissated in place; and the abundant graphitic matter in the garnet" (see under Essonite, p. 42) "gives indication of the same origin." This corundum occurs in association with cyanitic mica-schist and fibrolite gneiss at Barkhamsted, Conn., where the latter rock carries the singular graphite-coated garnets described on page 42.

RUBY.

BURMA.

A recent article on Burman ruby mines, by G. Eisfelder,[b] develops little beyond what had already been given by English writers. He

[a] Am. Jour. Sci., 4th ser., vol. 14, No. 81, pp. 235-236.
[b] Burma ruby mining: Berg- und hüttenm. Zeit., No. 1, 1902, pp. 1-8.

regards the old Mogok region of Upper Burma as still the most important, more so than the ruby mines of the Nanyadeik precinct in the Myit Kyina district, or those near the Sagiu-mount in the Mandole precinct. The rubies are found in a mass called by the natives "byon" (clay), considered by C. Barrington Brown and Professor Judd[a] to be a residual product of decomposed crystalline marble, which contains also sapphires, spinels, and tourmalines. The marble, mostly coarse granular, is supposed to be developed by contact metamorphism from a dolomitic limestone, which belongs, as Professor Noetling has stated, to the Upper Carboniferous. Limestone of this kind is found in many places unaltered, while at other points it appears changed into marble from penetration by eruptive rocks. The clay containing precious stones mixed with sand is found lying on the sides of the valley, and also occupies large depressions sometimes to the extent of a kilometer, which frequently penetrate the limestone itself as cavities. The same name (byon) is also applied to the ruby-bearing gravel bed underlying the alluvial deposits throughout a large extent of the Mogok Valley.

Rubies are the only important gem product of India at present, and these are confined to Upper Burma. In the Mogok Valley the Burma Ruby Mining Company, Limited, is at work actively, and has produced 210,784 carats of rubies, 9,786 of sapphires, and 10,241 of spinels, as the output of 1902. The workings are open excavations to and into the ruby-bearing gravel to a depth of 50 feet, and present a resemblance to the early stages of the Kimberley diamond mines, though of course the conditions of occurrence are widely different. The "byon" or gem gravel is raised to the surface by endless rope haulage, crushed in rotary pans, and the gems finally separated by pulsators and hand picking. It seems remarkable that the company has not introduced the grease separator, which has proved so effective in place of hand picking at the African mines. Besides these large workings of the company, a number of small ones are let to natives, who pay a royalty on the product. In view of the ease with which valuable gems are secreted, this can hardly be a profitable arrangement for the company, but it is probably maintained chiefly as a conciliation to the native interests, as prior to the British occupation the natives had worked the alluvial deposits for generations and regarded it as a right.

A writer in the Allahabad Pioneer Mail points out that fuel in the vicinity of the Burma ruby mines has now become exceedingly scarce, and has to be brought from a considerable distance. In the near future it is probable that an electric plant will be introduced, as extensive water power exists to furnish an abundance of electricity should

[a] The rubies of Burma and associated minerals: Trans. Royal Soc. of London, vol. 187, A, pp. 151-228; Seventeenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1895, pp. 905-907; and Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 5, 1896, pp. 19, 20.

it be desired. The Mogok ruby district is by no means exhausted, but new regions have also been discovered, notably in the Chin country some miles to the southwest, and it is believed that this district will prove as important a factor in ruby production as that of Mogok itself.

Ruby trade in Burma.—A recent article in Le Diamant, Paris, 1902, gives accounts of the Burman ruby trade and of the native cutting. The estimated value of rubies sold annually in Mandalay amounts to $1,000,000 (30 lakhs of rupees). The leading gem dealers of Amsterdam and of Paris have agents who deal directly with the Shans, and the finest rubies are destined for the French capital. The traffic is conducted in peculiar ways, very interesting to the foreign observer. Certain conditions are rigorously maintained, as to the time of day for examination and purchase, and a system of signs for bargaining and agreement.

In examining rubies, the Shans never use artificial light, holding that full sunlight alone can bring out perfectly the color and brilliancy of the gems. Sales must therefore take place between the hours of 9 and 3, and the sky must be clear.

The purchaser, placed near a window, has before him a large copper plate. The sellers come to him one by one, and each empties upon the plate his little bag of rubies. The purchaser proceeds to arrange them for valuation in a number of small heaps. The first division is into three grades, according to size: (1) Those of 3 grains or less; (2) 3 to 6 grains; (3) 6 to 10 grains; any larger stones are set aside to be valued separately.

Each of these groups is again divided into three, according to color, the first quality being called extra red, the second pale, the third dark, or poorly colored. A further division is made, again into three grades, according to shape: (1) Those which will cut well; (2) those that will lose more than half their weight; (3) those that can not be cut, but only polished (rounded). There are thus 27 grades in all, besides the larger rubies that are estimated singly.

The bright copper plate has a curious use; the sunlight reflected from it through the stones brings out a color effect with true rubies different from that with red spinels and tourmalines, which are thus easily separated.

The buyer and seller then go through a very peculiar method of bargaining by signs, or rather grips, in perfect silence. After agreeing on the fairness of the classifications, they join their right hands, covered with a handkerchief or a flap of a garment, and by grasps and pressures, mutually understood among all these dealers, they make, modify, and accept proposals. The hands are then brought out, and the prices are recorded.

The larger single stones are valued according to color and shape for cutting, the very fine ones bringing high prices. A ruby of 36½ carats from the Mogok mine some years ago brought 90,000 rupees ($30,000) at Calcutta.

Cutting is an important industry at Mandalay, and the Burmese workmen have remarkable skill, especially in avoiding loss in weight. European cutting they consider very wasteful, and at Mandalay a man would not be employed who sacrificed more than one-fourth of a ruby, while at Antwerp a loss of two-thirds is not uncommon. The tools are extremely simple. The stone is first shaped with a small steel chisel and wooden mallet, as far as possible according to its cleavage. The facets are then ground and polished on a copper wheel with ruby dust, the stone being held with wax or lac on a curved piece of ox-horn. A month or six weeks may be occupied in cutting and polishing a ruby of 1 carat.

The pale stones, cut rounded (cabochon) with a concave base, are much used for ornamental work, especially upon gold vessels. The luster of the gold beneath appears to enrich and darken the ruby and give it the true pigeon's-blood color.

BORNEO.

Ruby and sapphire corundum are reported as occurring in Borneo, in an article by Fr. W. Voit from geological and mining notes in the eastern part of that island.[a] They are found in small pieces, associated with gold, in the beds of mountain streams tributary to the Pâsir River in the sultanry of that name. It is notable that the associated gold occurs only in the lower portions of these little rivers, and in wire-like and "toothed" (crystalline) forms, not rolled, a fact indicative of a near source; but no particulars are given as to the corundum.

RUBY UNDER ULTRA VIOLET LIGHT.

In 1902 M. Chaumet read a paper before the Académie des Sciences de l'Institut, Paris, concerning an important result attained with rubies by experimentation with violet light similar to that tried on diamonds, as already mentioned. The Burmese rubies have a higher value than those of Siam, although in outward aspect they differ so slightly that even experts may easily fail to distinguish them, and no precise definition of their difference can be given. The radiograph affords no aid, but M. Chaumet finds a marked distinction under the action of violet light. The Siamese rubies allow the violet rays to traverse them, with little or no fluorescent effect; but the Burmese stones all fluoresce markedly and present a vivid red glow. By this means the gems from the two sources, however mingled, may be easily separated. Dr. Charles Baskerville and the writer are examining all the gems of the Morgan collection with this light, the Roentgen rays, and radium.

[a] Berg- und hüttenm. Zeit., Nos. 38, 39, 1902, pp. 445-459.

BERYL AND EUCLASE.

SIBERIA.

N. Orlow describes a new locality of beryl in eastern Siberia, near the Mongolian frontier, on a tributary of the Yasakin River.[a] The beryl occurs in veins of pegmatite, which, at the point where the beryl is found, pass into a mica schist. The crystallography of the beryl is described, and some optical anomalies noted, which the author attributes to an intermixture of euclase, as indicated by analysis, to an extent of about one-fifth. This euclase admixture appears to increase from the central portion of the crystals, where it forms only one-fifteenth part, toward the exterior, where it seems to constitute an outer zone, which is optically biaxial, while the central portion is normal.

GERMAN EAST AFRICA.

W. Bornhardt and B. Kuhn[b] mention beryl in long light-green crystals, occurring in pegmatite, in the district of Namaputa on the Muiti River, tributary of the Rovuma, in German East Africa.

TOPAZ.

WEST AUSTRALIA.

A remarkable discovery of topaz has been announced by Mr. E. S. Simpson, mineralogist to the Geological Survey of West Australia,[c] and fuller particulars are given in a subsequent letter to the writer. The locality is in the Coolgardie gold field, and near the town of Londonderry; the occurrence is in a dike of very coarse pegmatite, traversing amphibolite rock. The composition of the pegmatite is peculiar in that the mica is mainly lepidolite, and that topaz is present in large amount. The lepidolite is of amethystine tint, and has been found in sheets up to a foot square, or even more. Analysis shows it to be a true lepidolite, but almost anhydrous, and with rather less potash and with more soda and lithia than usual. The topaz is described by Mr. Simpson, in his letter, as in enormous rude crystals, up to 6 feet long and 2½ feet across. The rock has been disturbed and broken by subsequent geological action, so that the minerals are much fractured and crushed, and the topaz crystals have been rendered white and opaque on the exterior and along numerous cracks and fissures. Within they are pale blue and transparent, but so much broken that only small

[a] Verh. Russ. min. Ges. (2), vol. 37, 1899, Prot., pp. 48–49.

[b] Bornhardt, W., Zur Oberflächengestaltung und Geologie Deutsch-Ostafrikas, Berlin, 1900 (cf. Zeitschr. f. Krystall. u. Miner., vol. 36, pt. 4, Leipzig, 1902, pp. 420, 421).

[c] Simpson, Edward L., Bull. Western Australia Geol. Survey No. 6, 8vo., 89 pp., and plates; Perth, 1902.

pieces of gem-material are procurable; these are so light in color as to appear like clear white topazes. Mr. Simpson hopes that perhaps further opening of the rock may reveal material in better condition. An analysis is given, which shows the mineral to have the composition of a normal topaz.

ZIRCON.

QUEENSLAND.

Zircons, usually small, but sometimes of gem quality and good size, are found with the sapphires, elsewhere described (see p. 34), in the ancient alluvium, the sapphire wash, of central Queensland.[a] Some of them are colorless, with brilliant luster and rounded faces, and have quite naturally been mistaken for diamonds, but the majority are of various shades of brown and red. One large, red piece yielded a cut "hyacinth" of 15 carats, but those uniting size, transparency, and rich color are scarce.

Zircon, in regard to its color, has long been known to be sensitive both to heat and to sunlight, and the statements made in the report of Mr. Dunstan are of special interest in this respect, as definite accounts from a new locality. He says that these color changes are very marked in some of the zircons of the Anakie district, so that paling of tint is caused sometimes in stones that have been carried about in the pockets of miners, apparently by the mere warmth of the body, and that gentle heating is actually resorted to in order to render lighter the tint of zircons that are too dark. If the heat is slight, the former color may return as the stone cools; if too strong, the stone is decolorized entirely and permanently. The change may affect only the depth of color, but it usually renders the reds more or less brown. A remarkable fact, however, is that no such effects are produced, according to Mr. Dunstan, by the heat employed by lapidaries in cementing gem zircons to the holder for cutting and polishing, nor by the heat of the friction involved in those processes, though to this last point he does not refer directly.

Insolation also changes the color, but its effect is usually temporary, the original tint returning. One very interesting case is noted, that of a stone decolorized by heat, which partially regained its color after exposure to sunshine.

The whole subject of the effect of heat and sunlight on color is one deserving a careful scientific investigation, which has never been made. It would furnish a most interesting field for study and experiment, both as to zircons and as to other gem stones.

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[a] Dunstan, B., The Sapphire Fields of Anakie: Geol. Survey, Queensland, Brisbane, 1902.

GARNET.

ESSONITE.

CONNECTICUT.

Prof. B. K. Emerson, in the American Journal of Science for September, 1902,[a] describes a very peculiar occurrence of essonite garnet, partly coated and penetrated with graphite, at Barkhamsted, Conn. The garnets form a surface-layer on a bed of fibrolitic gneiss, and appear as large dodecahedral crystals, as much as 2 inches in diameter, much grown together. The faces are dull and cavernous, sometimes inclosing grains of calcite, and Professor Emerson thinks that the crystals developed from the gneiss surface into an overlying bed of calcite, since removed by erosion. In color they are pale yellowish, largely weathered to gray, and more or less covered or blotched with dull black graphite. This graphite stain extends below the surface for about half an inch, and there ceases abruptly, the plane frequently passing through the middle of the crystals of garnet; the graphite also runs farther into streaks and wedges. The real essonite is little more than an exterior zone or shell, however, the mass of the crystals proving under the microscope to be largely composed of a mixture of wollastonite, calcite, quartz grains, and diopside. The whole occurrence is very peculiar.

RHODOLITE.

NORTH CAROLINA.

The beautiful rhodolite garnet of Cowee Valley, in Macon County, N. C., has been extensively worked during the last year, the total output being estimated at $1,500, as against $27,000 in 1901. Mr. William E. Hidden, who has been actively interested in the development of the rhodolite, states that larger single pieces of it have been obtained than at any time before—one of 59 carats, the largest previously reported having been 23, 28, and 43 carats.

PYROPE.

ARIZONA AND NEW MEXICO.

Pyrope garnets of fine quality are found at several localities in New Mexico and Arizona, and have been referred to in previous reports of this Bureau. The principal locality in New Mexico is on the Navajo Reservation, and the finest large specimen from there is the property of Mr. W. T. Kaufman, of Marquette, Mich. It is more than half an inch

[a] Am Jour. Sci., 4th ser., vol. 14, pp 231-235.

in diameter, weighs 11⅛ carats, and has a magnificent red color, equal to any garnet that the writer has seen from any locality. They are also found at some places in northern Arizona, and one of the finest, from near Fort Defiance, was figured by the author several years ago.[a] They occur loose in or near the surface, and are gathered by Indians, soldiers, and cowboys, principally from around ant hills and scorpion holes, where they are brought up and thrown out by the insects. Their source is doubtless in peridotite rocks, weathered out in the decomposition of the outcrops.

BOHEMIA AND SAXONY.

The Bohemian garnet beds and the alluvial gems of the Seufzergründel near Hinterhermsdorf, Saxony, have been described by Dr. I. H. Oehmichen in an article on "Die böhmischen Granatlagerstätten und die Edelsteinseife des Seufzergründels bei Hinterhermsdorf in Sachsen."[b]

The Bohemian garnets occur on the southern slope of the central chain of the Bohemian Mountains, either in genuine alluvial deposits (at Chodolitz, Podseditz, Chrastian, Triblitz), or in a decomposed peridotite (at Meronitz), or in tufa, breccia, and fragmental rocks (at Linhorka Hill, near Starry). At the first two places mentioned, the garnets belong probably to the latest stage of the Tertiary period. The basins containing garnets occupy an area of 70 square kilometers and extend in different directions. In the basins fragments of basalt are the rock chiefly found, but there occur also gneiss, granulite with garnet and cyanite, granite, mica-schist with garnet crystals (110) up to 2 centimeters in diameter, serpentine with pyrope not infrequently, porphyry, Pläner clay, and Tertiary sandstone. The garnet is associated in these basins with the following minerals: Zircon, in reddish-brown to yellow-brown crystals with rounded faces (111); (110) (111); (100) (111); spinel (ceylonite), spherical granules scarcely red in color; corundum (sapphire and ruby), in angular fragments, rounded granules and crystals of pyramidal aspect; cyanite, less frequently; tourmaline, in small black prisms; olivine, in rounded, mostly crisp, granules and small crystals; quartz; opal; calcite; aragonite; barite; magnetite; brown iron ore, partly pseudomorphous after iron pyrites; augite and hornblende in crystals and fragments of typical basaltic character, and moldavite.[c] Former reports on the occurrence of topaz, bronzite, and titanite could not be verified by Herr Oehmichen.

Mention is made of the finding of a diamond at Dlaschkowitz. On the basis of oral communications by Dr. Vrba to Dr. R. Beck, the

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[a] Gems and Precious Stones of the United States, 1892, Pl. III, fig. A.

[b] Zeitschr. f. prakt. Geol., 1900, vol. 8, pp. 1-16.

[c] Zeitschr. f. prakt. Geol., 1900, vol. 33, p. 649-650.

features of this diamond must be deemed entirely different from those of the India and Brazil diamonds, and hence it was considered to be the only representative of a special type. The origin and finding of this same diamond were fully described by the author after a visit to the garnet fields of Bohemia, when he saw the stone in the great collection of the University of Prague in 1891. He was then, and is still, fully convinced of the Bohemian source of this diamond.[a]

The conglomerates containing garnet near Meronitz are treated of by Dr. Oehmichen on the foundation of earlier reports on that subject. Of the genesis of the garnet beds he gives a detailed account, indicating that the garnets came from an olivine rock, probably lherzolyte, and that they were brought up by a volcanic eruption which formed the hill called Linhorka, near Starry. In the tufas surrounding the hill occur nearly all the minerals and conglomerates containing garnets. From that tufa the minerals have been transported to the diluvial basins.

The alluvial gems in the Seufzergründel near Hinterhermsdorf ("Sächsische Schweitz") have some likeness to the Bohemian garnets of the alluvial deposits. In the little valley or basin are frequently found sand layers containing unusually large quantities of magnetic iron ore, and also magnetic iron associated with titanite; besides these there are also fragments of hornblende, augite, bronzite, diopside, zircon up to 7 millimeters in size, ceylonite, and corundum. As matrix there occurs in these sand masses some glassy basalt containing olivine and hornblende, and an associated breccia. In the latter occur peculiar inclusions showing a gabbro-like structure, and sometimes products of basalt, which have been cooled and solidified in the depths of the earth. From the basalt and the breccia is probably derived the alluvium, and from the gabbro-like rocks originally came the larger part of the spinels.

For a recent statement as to the falling off in the Bohemian garnet industry for some years past, see page 70.

ALMANDITE.

GERMAN EAST AFRICA.

A brief notice of the discovery of almandite in German East Africa appeared in the last report of this Bureau.[b]

Dr. A. Miethe, professor in the technical high school at Charlottenburg and director of the photochemical department of the same school, sent a highly appreciative letter to Mr. Fred. Marquordt,

[a] Kunz, George F., The garnet fields of Bohemia: Trans. Am. Inst. Min. Eng., 1892, Feb. meeting, Sup., pp. 1-9, with map.

[b] Mineral Resources U. S. for 1901, U. S. Geol. Survey, 1902, p. 746.

owner of the garnet mines in Luisenfeld, in Linde-Hinterland, German East Africa, expressing his pleasure in being able, after careful examination, to communicate a favorable report, especially as Germany has not many of the precious stones. The letter[a] states that the German East African garnets are next in rank to the so-called rubies of the Cape, which occur, together with diamonds, in the Kimberley mine and in the other African diamond diggings. A careful comparison of these latter shows their close likeness to those of German East Africa. But in Luisenfeld there have not been found stones of white, yellow, or brown color, like the majority of those found at Kimberley. The choice cut stones made by order of Dr. Miethe from the pieces sent to him for examination, show the exceedingly fine quality of the rough material. The luster is very beautiful, exceeding that of the Indian and Bohemian garnets, and even of those from Arizona. The color of the stones is a pure carmine. The garnets from Luisenfeld have also the rare quality of not changing color in the evening; the tint does not darken, but the play of color seems more beautiful in gaslight than in sunlight. The average color of single stones is comparatively light. This is an advantage, because it is consequently possible to cut larger gems having more brilliant effects. The Cape rubies have been found only in small pieces; but in Luisenfeld the rough material is of much larger size, and after cutting it shows no flaws. To Dr. Miethe as an expert was sent for examination a perfectly regular cut stone, absolutely faultless, of admirable color, 15 carats in weight. In view of these facts, it is evident that the finding of these large, light-colored stones of exceedingly rich color in such abundance is indeed an important circumstance.

The Cape rubies and the Arizona garnets, as well as those so long and extensively worked in Bohemia, belong to the species pyrope, which never occurs in masses of any size, but in small rounded pieces from the amygdaloidal cavities of igneous rocks. The Luisenfeld stone is apparently almandite, the precious garnet of jewelers, which occurs in larger pieces and often in well-defined crystals.

A further account of this interesting discovery has been given by W. Bornhardt and B. Kuhn in a series of mineralogical notes published in a work by the former.[b]

The locality is on the Namaputa River, a tributary of the Rovuma. The garnet occurs in a decomposing hornblende gneiss, whence it is liberated in rounded masses up to the size of a man's fist, probably representing large crystals, irregularly distributed through the rock. It is usually transparent, of a columbine-red inclining to brownish-red, and is suitable for good jewelry. But the authors of the work

[a] Schlesische Zeitung, Breslau, October 10, 1902.

[b] Zur Oberflächengestaltung und Geologie Deutsch-Ostafrikas, Berlin, 1900. Cf. Zeitschr. f. Krystall. u. Miner., vol. 36, pt. 4, Leipzig, 1902, pp. 420, 421.

cited question whether continuous mining of it would be profitable, especially as other localities of garnet have been discovered, though not of such good quality. The analysis given of this garnet is interesting, as representing an almandite in which the ferrous oxide has been largely replaced by magnesia, and to some extent by lime, showing its approach in part to a pyrope, and suggesting some molecular combination of the two species, such as has been recognized in the case of the North Carolina rhodolite,[a] though quite different from that instance. The density, too, is very low for almandite, and both in this particular and in the composition the description approaches very nearly the analysis (No. 13) given by Dana, under pyrope, of a Cape ruby.

Analysis of almandite garnet, German East Africa.

Constituent.	Per cent.
SiO_2	38.87
Al_2O_3	23.15
FeO	20.55
CaO	5.58
MgO	11.74
Total	99.89

Specific gravity, 3.875.

TOURMALINE.

CONNECTICUT.

The tourmalines and associated minerals from Haddam Neck, Conn., previously described in these reports,[b] have been very fully investigated and described by Mr. H. L. Bowman, in the Mineralogical Magazine,[c] London, on the basis of a representative collection of some eighty specimens, presented to the Oxford Museum by Mr. Ernest Schernikow, of New York, who was largely engaged in exploiting the albite quarry at the locality in which these minerals occur.

The paper treats of ten species, of which the collection contains examples, and mentions three others not represented—microlite and columbite, which are reported as occurring at Haddam Neck, and the chrysoberyl of Haddam, on the opposite side of the Connecticut River. The ten species are muscovite, lepidolite, cookeite, albite, microcline, quartz, beryl, fluorite, apatite, and, of course, the lithia tourmaline. They occur chiefly in a large vein or rather dike of pegmatite, in which albite, quartz, and muscovite are the conspicuous elements.

[a] Twentieth Ann. Rept. U. S. Geol. Survey, pt. 6 (cont.), 1898. Mineral Resources U. S. for 1901, U. S. Geol. Survey, 1902, p. 744.

[b] Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 5 (cont.), 1897, pp. 1183–1204; Nineteenth Ann. Rept., pt. 6 (cont.), 1898, p. 505; Twentieth Ann. Rept., pt. 6 (cont.), 1899, p. 602, Pl. I, fig. E.

[c] Mineralogical Mag. and Jour. Min. Soc., May, 1902; vol. 13, No. 60, pp. 97–121, and Pl. IV.

The other species appear chiefly in cavities or pockets, lined with crystals of more or less smoky quartz and the feldspars.

The paper dwells especially on the remarkable intergrowth of muscovite and lepidolite, which is familiar to all who are acquainted with specimens from this place, and also with specimens from some of the Maine localities. The peculiar association of these two species, their modes of grouping and twinning, etc., are investigated and described in detail. Much interest attaches to the curious fibro-prismatic rose-colored modification of muscovite from this locality, that has lately become somewhat familiar. Chemical and optical examination show it to be a true muscovite, though so different in general aspect from ordinary micas, and to consist of minute and very elongated rhombic crystals attached in either parallel or twin position, "so that the whole mass can be cleaved across like a single crystal." The separate components, looking like fibers, are not however prisms, but excessively long and slender pyramids. The tourmalines are discussed optically and crystallographically, and the peculiar color sections are noted and referred to successive growths. The planes of demarcation, as is well known, are usually parallel to the base, a fact which is remarked upon as rather singular when the basal plane is so rarely developed in the perfect crystals. One specimen is figured, in which the green central and pink terminal portions are separated by the ordinary low trigonal pyramid.

Beryl appears in two forms, one greenish-white, and the other pale pink; the latter is noted as of interest as probably containing cæsium, which has been found in similar specimens by Penfield, though no analysis is given of it here.

The apatite is treated at length crystallographically. It also presents two varieties, a grayish-green, in hexagonal tables, and a more prismatic pink form.

In general, Mr. Bowman refers to the close resemblance between the minerals of Haddam Neck and those of the Maine localities of albite-pegmatite and of some others in New England. The same intimate association of lepidolite, forming borders on crystals of muscovite, appears at Auburn, Me., and even to some extent also the external zone of fibrous muscovite. The intergrowth of muscovite with quartz and of microcline with quartz are also noted, and the determinations of Wells and Penfield and Harper as to the presence of cæsium oxide (1.66 to 3.6 per cent) in beryls from Hebron and Norway, Me., are closely paralleled by the Haddam Neck variety. As to the order of formation little can be affirmed, the minerals being so mingled that they must have been nearly contemporaneous. The quartz and microcline are evidently among the last, from their inclusion and envelopment of tourmaline and of some of the micas. Among the latter the order is always muscovite, lepidolite, and the pink fibro-prismatic muscovite on the outside.

NEW YORK.

An article of great interest from a scientific point of view appeared in the American Geologist[a] for June, 1902, on "Tourmaline contact zones near Alexandria Bay, N. Y.," by C. H. Smyth, jr., of Hamilton College, Clinton, N. Y. The data and conclusions have special interest in regard to the origin of tourmaline, and its relation to igneous dikes and to veins, and to the connection between the two last-named phenomena, as traceable in certain of the islands of the St. Lawrence and the adjacent shores near Alexandria Bay. On Wellesley Island the contact is well shown between igneous and older sedimentary rocks, the former representing the great granitic and gneissic complex of the western Adirondack region, and the latter a body of schists, gneisses, and quartzites of pre-Cambrian age. Both series have undergone extensive alteration, but their general characters are well discernible.

The granitic series cuts the sedimentary at many points, and includes multitudes of fragments from the quartzite and schists. Dikes and veins are abundant. The larger dikes have the prevailing character of the granitic and gneissic mass of the mainland, with which they are undoubtedly identical, while the smaller dikes become coarser in texture and more quartzose in composition—in other words, become pegmatitic—and black tourmaline appears as a marked ingredient. The narrower these dikes become, the farther do they penetrate the older rock, relatively if not absolutely, and the more they take on the aspect and much of the character of aqueous veins. But even more remarkable is the difference seen in the contact phenomena of the larger dikes as compared with the smaller dikes in the schists. These latter, indeed, show more or less local alteration from the intrusion of the masses and the larger dikes, but far more effect is apparent along the smaller dikes and veins. Along these there is a pronounced development of tourmaline in the schists, in exceedingly varied forms, which Professor Smyth in part describes. But the striking fact is, as he expresses it, that "in a general way, the amount of tourmaline seems to vary inversely as the width of the dikes," and that it "becomes relatively greater as the offshoots become more quartzose." These two statements, as he adds, are essentially the same, since the narrow offshoots are the richest in quartz.

Comparing these phenomena with somewhat similar ones reported in Colorado by Prof. H. B. Patton,[b] the author goes on to trace the stages in the development of these dikes and veins and their influence on the penetrated rocks. The granitic magma of the large masses would force its way unchanged into the wider fissures, while through the influence of heated water and gases with which the magma must,

[a] Am. Geologist, June, 1902, vol. 29, No. 6, pp. 377-383.
[b] Bull. Geol. Soc. America, vol. 10, pp. 21-26.

of course, have been charged, the narrow offshoots, with fluid products of hydrothermal fusion, were injected into the narrower fissures and cracks, often to long distances. "Indeed," he says, "starting from the normal granite, we might expect to find a gradation to a pure quartz vein, * * * filled by hot solutions of silica having their origin in the granite. * * * This series is pretty well represented; but the quartz, as a rule, is accompanied by some tourmaline, * * * indicative of the boric vapors so common in granite intrusions." According to this view, the increased development of tourmaline along the smaller veins finds a natural explanation.

A number of additional points are dwelt upon which can scarcely be treated of here. Professor Smyth points out that, as to the tourmaline in the granitic veins themselves, the general position of the prisms at right angles to the vein is evidence both of the fluid condition of the magma and of the absence or the cessation of injecting pressure at the time when the crystals formed. As regards the tourmaline in the schists, it is plainly derived from the biotite of the latter, which is abundant where the rock is unaltered and absent in the contact zones where the tourmaline appears.

In the process before outlined it follows clearly that the narrow, vein-like dikes represent a protracted stage of development, continuing long after the larger masses and wider dikes had measurably solidified; and that thus quartz veins and slender dikes of pegmatite, even cutting the true granitic dikes, may have been produced, subsequently, indeed, but actually as a continuous part of the same general body of igneous activities.

Passing to some other localities on the mainland, in the towns of Omar and Alexandria, where specimens of hematite in feldspar have long been obtained by mineralogists, Professor Smyth finds a similar condition, though with some variations. "Here, too," he says, "it is possible to find every gradation from these mineral veins, through pegmatites to dikes of normal granite; and there seems no question that the veins owe their existence to the granitic intrusion." But they themselves are yet true veins, not dikes, and were filled by heated solutions and not by melted rock.

URAL MOUNTAINS.

In the Bulletin of the Ural Society of Natural Science[a] has appeared an "Index of minerals which occur in the mining districts of the Ural Mountains," by W. P. Yarkov.

Among other interesting references, a remarkable occurrence of green tourmaline is noted near the village of Schabrov (district of Ekaterinbourg). Arzruni, who had received a specimen from this

[a] Bull. Ural Soc. Nat. Sci., 1901, Ekaterinbourg, vol. 22, pp. 26-36.

locality, and also from the works at Berezov, wrote of it from Berlin to the Imperial Mineralogical Society in 1882, saying that it was of exceeding interest from the fact that, like alexandrite, its pure green color changed to a ruby-red in artificial light, and adding that this is only the second mineral showing this remarkable property. A double refraction is also noted in connection with these green tourmalines, but no particulars are given. The two optical anomalies may have some relation to each other, which no doubt will be fully investigated.

Other colored tourmalines are also mentioned—rose-pink, with black, in a talcose rock; and wine-yellow to dark brown, containing some chromium, associated with fuchsite and chrome-iron, on the left bank of the Kamenka River, a mile northwest of the Suisserski works (district of Suissersk). Prof. P. W. Jeremejev, the secretary of the Imperial Mineralogic Society, had stated in 1882 that thin plates of this tourmaline appear to show a double refraction by artificial light, together with a difference of color.

Corundum is merely mentioned, with no particulars as to color or quality, as found in the sands of the Kornilov Valley (district of Mursinsk).

ORIGIN OF TOURMALINE.

Prof. Giovanni d'Achiardi, of the University of Pisa, has published an article on the metamorphism of limestone by contact with granite, at Porto dei Cavoli, on the island of Elba.[a] Having previously described a similar case of local alteration at Berdiauch in the Urals,[b] he was led to pursue the subject further, as developed on the island of Elba, at the famous tourmaline locality, which had been studied by himself, and also to some extent by others, from 1899 to 1902. The limestones at this locality are closely associated with a body of metamorphic schists of various mineralogical character, traversed and locally modified by granite veins; these have all been described somewhat fully by Lotti, who refers the schists to presilurian sediments.[c]

Professor d'Achiardi enters into a detailed account of the characters of the granite, which presents several varieties of texture and composition, due in part at least to its proximity to the limestone; describes a narrow zone of alteration at the actual contact, showing a mutual action of the two rocks on each other; and describes the limestone itself as affected by the granite. The whole body of schists, in which the limestone beds occur, is thoroughly metamorphic, and the limestone has the character of either a saccharoidal marble or a slightly foliated cipolin; but the local contact action shows itself in the development of various accessory minerals in the marble, some conspicuous,

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[a] Atti della Societa Toscana di Scienze Naturali residente in Pisa, Mem., vol. 29, 1902, (separ.) pp. 1-41, Pls. IV, V, VI.

[b] Id., Mem., vol. 16, 1898.

[c] Descrizione geol. dell' isola d' Elba; Mem. descr. d. Carta geol. d' Italia; Roma, 1886.

but chiefly minute. Wollastonite is prominent; others are pyroxene (malacolite), dipyre, vesuvianite, grossularite, etc. These were all studied in detail as to their proportions, vicinity to the contact, etc., and are illustrated by plates of magnified sections. The whole is a very interesting study of what may be called secondary metamorphism, where local contact has produced mineralogical changes in an altered sediment already thoroughly crystalline.

OPTICAL PROPERTIES OF TOURMALINE.

E. A. Wulfing, in an article on the different rates of vibration of light in tourmaline,[a] gives his investigations on the optical properties of tourmaline as compared with quartz, and contests the views of C. Viola in regard to these minerals, wherein the latter has questioned the theory of Fresnel. Viola experimented on quartz with the total reflectometer of Abbe, and praises the extreme accuracy of that instrument. Wulfing admits this claim, conceding its accuracy to the fourth decimal place, but holds that the differential method of Dufet gives more exact results, though only with extreme care on the part of the observer.

Viola's minute difference of 0.00016, in the exponents of the ordinary ray in quartz (as parallel or transverse to the *c* axis), Wulfing regards as unsatisfactory, from possible defects of the instrument, and also as obtained from but a single specimen, and hence as not sufficient for a conclusion so important as to discredit the theory of Fresnel.

In tourmaline crystals from Elba, Viola had found results with sodium light, which again appeared to show that the vibrations proceed otherwise than as stated by Fresnel. Wulfing commented on these in 1900,[b] and again in the present article, pointing out that Elba tourmalines are known to be optically variable, even in different parts of the same crystal, and that hence, in order to draw any important conclusions from such specimens, the measurements must needs be made in the different directions at the same point in a crystal. He then goes on to describe at length his method of cutting prismatic or pyramidal sections from tourmaline crystals, so as to examine the rates of vibration of a ray in axial or transverse direction from exactly the same point in the same material. He gives details of his results thus obtained, and concludes that the doctrine of Fresnel is thereby fully borne out.

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[a] Separat-Abdruck aus dem Centralblatt d. Min., Geol., u. Palæont.; Stuttgart, 1901, pp. 299-302.
[b] Hohenheimer Program, 1900, p. 48.

JADEITE.

MEXICO.

Dr. Leopoldo Batres, the Mexican archæologist, has lately published a remarkable monograph, sumptuously printed and illustrated, entitled "Explorations of Mount Alban."[a] This locality is a hill or small mountain, one of a group some 5 miles southwest of the city of Oaxaca, and is notable for a number of large ruined structures, chiefly of a religious character, on its sides and summit. These are very ancient, as is shown by many indications, and furnish some of the best examples of the little-known type of Mexican civilization termed the Zapotecan. The people who constructed the buildings and sculptures of this type Dr. Batres regards as having close relation with the Mayas, and the ruins present marked resemblances to those of Palenque and Uxmal.

The ruins on Mount Alban consist of groups of teocallis, or stepped pyramids with flat summits, whereon were doubtless temples, long since gone. The hillsides are also full of sepulchers and mortuary chambers, with remarkable architecture and carvings. In the vestibule of one of these Dr. Batres discovered a highly ornamented vase of pottery, containing about fifty small pieces of jadeite; some of them were elaborately carved amulets, others were beads, round or cylindrical, and some were of irregular forms. They were of fine quality and color, green and blue, but, strange to relate, bore traces of having been painted red. The carvings upon them, as also the ornamentation of the vase, are thoroughly Mayan, and in one case identical with an object from Palenque. All are figured in the monograph.

Both as specimens of jadeite and as archæological treasures, these are of great interest.

NEPHRITE.

NEW SOUTH WALES.

Dr. Card[b] records that jade (nephrite), but poor and of little or no value, as the polishing quality is not good, is reported from Wentworth mine, Lucknow, New South Wales.

EPIDOTE.

ALASKA.

The fine crystals of epidote from Prince of Wales Island, Alaska, announced in the last report of this Bureau,[c] have been made the subject

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[a] Explorations of Mount Alban, by Leopoldo Batres (Inspeccion y Conservacion de Monumentos Arqueologicos de la Republica Mexicana), Mexico, 1902 (small 4to, 37 pp, 25 plates and map).

[b] Record of the Geological Survey of New South Wales for 1902, vol. 7, pt. 2, pp. 29-46.

[c] Mineral Resources U. S. for 1901, U. S. Geol Survey, 1902, p. 745.

of a detailed notice, with plate, by Dr. Charles Palache, of the Harvard Mineralogical Laboratory, Cambridge, Mass.[a] Specimens were sent to the laboratory by Mr. W. C. Hart, of Manitou, Colo., who describes the locality at Sulzer, Prince of Wales Island, and the associated minerals, much as in the announcement above noted. Mr. Palache adds, however, that: "The country rock is limestone, which is cut by numerous igneous dikes, and it seems probable that the deposit is the result of contact metamorphism of the limestone by the dike rocks, resembling closely in this respect the epidote occurrence with copper ore in the Seven Devils Mountains in Idaho." The crystals are dark green to nearly black, but oil green and translucent when thin or fractured. The forms are varied and peculiar, sometimes quite unlike the ordinary aspect of epidote, the larger ones presenting the unusual type of nearly square tables, flattened parallel to *a*, and attached by an edge, measuring up to 5.5 centimeters in diameter (2.2 inches) and 3 centimeters in thickness (1.2 inches). The small crystals tend more to the usual prismatic habit.

Dr. Palache's paper is minutely and exhaustively crystallographic; he determines a large number of faces, some of them new for epidote, and some but imperfectly measured before. In conclusion, he says: "This Alaska epidote ranks among the finest occurrences of American crystallized minerals, and is only surpassed in the size, beauty, and complexity of its crystals by the epidote from the Knappenwand in the Tyrol."

A few of the best specimens found in 1901 have been sent to New York, and as groupings of large crystals, beautified with the association of quartz crystals, they have no rivals.

SPODUMENE (KUNZITE).

CALIFORNIA.

Transparent lilac-colored spodumene.—A recent remarkable discovery of unaltered lilac-colored spodumene has lately been made in California. The crystals were obtained 50 feet from a deposit of colored tourmaline—itself of notable interest—a mile and a half northeast from Pala, San Diego County. This new discovery is less than a mile northeast from the celebrated rubellite and lepidolite locality at that place, where recent developments have brought to light immense quantities of amblygonite, the latter species occurring by the ton, while the lepidolite is estimated by the thousand tons. The locality is thus unequalled in the world for its abundance of lithia minerals. The rubellite crystals found here are entirely embedded in lepidolite, and until recently it was found impossible to remove them to show their form. They were, however, often polished with the lepidolite,

[a] Proc. Am. Acad. Arts and Sciences, vol. 37, No. 19; March, 1902, pp. 531-535.

the rubellite appearing as radiations of pink in a darker gangue of a lilac-colored lepidolite. This year, however, the crystals of rubellite have been rubbed out, as it were—that is, made to stand out by removing the lepidolite matrix by means of brushes and cleaning tools, thus forming a most beautiful group of crystals.

At the new locality colored tourmaline crystals have been found that are remarkable in size and beauty, although they have been much broken in taking them out. Some are a foot long and 3 inches in diameter, with a red central core (rubellite) and a blue exterior (indicolite) separated by a pale intervening zone.

The spodumene crystals are beautiful in their color tones, varying in striking contrast from a deep pink-purple lilac, when taken at a depth, to a pale, almost colorless tint evidently due to weathering or to the action of the sunlight.

These spodumene crystals are of extraordinary size, transparency, and beauty, and are unrivaled by those from any known localities. Below are the weights and dimensions of six of the principal crystals:

Weights and dimensions of California spodumene crystals.

	Weight.	Weight.	Dimensions.
	Grams.	*Oz. troy.*	*Centimeters.*
No. 1..	528.7	17.1	17 by 11 by 1
No. 2..	528.7	17.1	22 by 8 by 1.5
No. 3..	297	9.55	19 by 5.5 by 1.5
No. 4..	256.6	8.25	23 by 4 by 2
No. 5..	340.5	10.95	13 by 6 by 2.53
No. 6..	239.5	7.70	18 by 4 by 2

Some crystals of spodumene purporting to come from Hermosillo, Mexico, were shown to the writer during the month of December. They are identical in habit, but much smaller than those from Pala. They were found in the White Queen mine, sec. 24, T. 9 S., R. 2 W., of the San Bernardino meridian, California. In either case no such spodumene crystals have ever before been found at any known locality. They are entirely distinct from the green crystals found at Stony Point, Alexander County, N. C., described by Dr. J. Lawrence Smith, and from the transparent yellow crystals found in Brazil, and described by Pisani.

The writer suggested that this was a distinct variety of gem of great beauty, and entitled to a new name. Dr. Charles Baskerville found that it differed from all other spodumene in its activity with ultra violet light, and named it kunzite.[a]

WEST AUSTRALIA.

Green spodumene.—In a recent report on the mines and minerals of West Australia, Mr. E. S. Simpson, mineralogist to the geological

[a] Science, August, 1903.

survey,[a] mentions an occurrence of spodumene of apple-green color in large prismatic crystals half a mile south of Ravensthorpe. Nothing is said of any portion of it as being transparent, but the color is of interest as presenting a type of this mineral intermediate between the ordinary whitish and altered form and the gem-variety hiddenite. Analysis shows this variety to be a spodumene rich in lithia and the alkalies and rather low in silica and alumina.

QUARTZ.

CALIFORNIA.

Small crystals of quartz resembling those from Herkimer County, N. Y., have been received from Dr. L. G. Yates, of Santa Barbara, Cal. They have been extensively advertised as white topaz, etc., on the strength of statements by local jewelers who claim to be experts on gems.

ELECTRICAL RESISTANCE OF QUARTZ.

The late Prof. Ogden N. Rood, of Columbia University, New York City, recently published[b] some investigations—almost his last work—on the electrical resistance, both internal and external (transmission and surface conduction), of various "non-conducting" bodies, usually so called. Among these were glass, quartz, and mica. The experiments were conducted with much difficulty and with great care, but owing to leakage at connections, etc., their results are announced as only approximate. The external or surface resistance of quartz was found to be for 1 square centimeter of crystal surface, 521,000,000 ohms, as compared with 1,590,000 for window glass, 22,000,000 for cobalt glass, and 50,760,000 for mica. Each of these values was the mean of several experiments. The internal resistance—1 square centimeter with a thickness of 1 millimeter—shows a surprising contrast, being for quartz only 885,000 ohms, while for mica (muscovite) it was 133,000,000. The tests on glass were unsatisfactory to Professor Rood, and he reserved them for further study. As the experiments on quartz, however, were made without reference, apparently, to the faces or axes of the crystals, fuller investigation of the subject from a more strictly mineralogical standpoint, with promise of interesting results, should follow the work thus begun by this eminent physicist.

CRYSTALLOGRAPHIC FEATURES OF QUARTZ.

In the Bulletin de la Société Française de Minéralogie,[c] several articles have appeared regarding peculiar crystallographic or related features in quartz. M. Ferdinand Gonnard furnishes four brief communications, with illustrations, on the occurrence of unusual planes

[a] Simpson, Edward S., Bull. Geol. Survey Western Australia No. 6, Perth, 1902, p. 57.
[b] Am. Jour. Sci., 4th ser., vol. 14, pp. 161-165.
[c] Bull. Soc. franç. de Min., vol. 25, Nos. 3, 4, 5, March, April, May, 1902.

on crystals of quartz from various localities, particularly from Brazil and Baveno, and M. G. Friedel treats of a peculiar instance of quartz twinning, and of corrosion figures produced in quartz by alkalies applied at high temperatures, as indicating crystallographic modifications caused by heat. The experiments described in the last of these articles were suggested by a statement of Chatelier in the same publication[a] that at a temperature of 570° quartz undergoes certain alterations in its optical properties, though not in its outward aspect, which indicate a change in molecular symmetry. M. Friedel endeavored to confirm this determination, and succeeded in doing so by treating quartz crystals with strong alkalies at temperatures near 600°, thus developing figures of corrosion that indicated the existence and the character of such a molecular alteration. These papers are all too minutely technical for anything more than a brief reference to them here.

SMOKY QUARTZ.

MAINE.

Since 1897 numerous pockets of smoky quartz have been found on the Littlefield farm, at Mount Apatite, Auburn, Me. Several tons of crystals in all have been obtained. One exceptionally perfect crystal weighing 12 pounds was found imbedded on the edges of a mass of cleavelandite, a short distance from the farm of A. S. Berry, in a deposit of large quartz crystals, feldspar, and gem tourmalines, of which more than 150 were obtained. A perfect 3-inch ball was cut from a smoky-quartz crystal found at this deposit, and is now in the collection of E. R. Chadbourne, of Lewiston, Me.

AMETHYST.

VIRGINIA.

Specimens of amethyst from Virginia, but nothing of importance, have been known to students and collectors for years past. Recently, however, a promising locality has been opened and some good gem material taken out, which occurred in pockets connected with a well-marked vein or stratum of white quartz which extends for some miles along the base of the Blue Ridge, and at certain points carries galena. The main locality is situated in Amherst County, some 2 miles from Lowesville post-office and about the same distance from the James River, at the foot of the mountains. It occupies an area of some 11 acres, and the amethyst occurs but a few inches below the surface. Only a few days' work was done with the simplest tools in exploiting the deposit.

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[a] Bull. Soc. franç. de Min., vol. 13, p. 112.

NONCRYSTALLINE QUARTZ.

AGATE.

The Borgia Chaldean agate ax.—An object of great scientific interest is the famous inscribed Borgia Chaldean agate ax. This ax was obtained by the Cardinal Borgia while at the head of the propaganda. The Contessa Ettore Borgia offered it to the British Museum some ten or twelve years ago, but at so extravagant a value (about £3,000 or £4,000 sterling) that it was returned to her. It was ultimately acquired, for some 15,000 lire, by the late Comte Michel Tysckiewicz. It is now in the Morgan collection of the American Museum of Natural History, New York.

The following extract is from Maspero:

Elle se trouvait dans l'ancienne collection du Cardinal Borgia et appartenait, il y a quelques années, au Comte Ettore Borgia. Elle a été publiée par Stevens (Flint Chips, p. 115), et en fac-simile par F. Lenormant (Tre Monumenti Caldei ed Assiri delle Collezioni Romane, 1879, pp. 4–9, et pl. VI, I); et Carvailhac (Âge de la Pierre en Asie), dans le troisième Congrès provincial des Orientalistes, tenu à Lyon (tom. I, pp. 321–332), a reproduit ce que Lenormant en avait dit.[a]

CHALCEDONY.

NEW SOUTH WALES.

Dr. Card[b] mentions that chalcedony containing included water (enhydros) has been found in magnificent specimens, some of them as much as 12 inches in diameter, at the Kingsgate bismuth mines.

CHRYSOPRASE.

NORTH CAROLINA.

An occurrence of chrysoprase is reported about 16 miles from Asheville, near Morgan Hill, Buncombe County, N. C. The material is encountered in several parallel seams, running with a general northeast–southwest strike, within a few feet of each other. At the surface the color is pale green, but as the rock was opened down to some 4 feet deep the color became darker and richer. Beyond a little test opening of this kind, no work has yet been done, and the value of the deposit can not as yet be judged.

OPAL.

CALIFORNIA.

Mr. C. R. Orcutt, of San Diego, Cal., refers to a great locality of opal in the region of the Mohave desert, in southern California. The

[a] Extract concerning agate ax-hammer head, from Maspero: "Histoire Ancienne des Peuples de l'Orient Classique: Les Origines; Égypte, Chaldée," p. 755.

[b] Record of the Geological Survey of New South Wales, for 1902, vol. 7, pt. 2, pp. 29–46.

mineral is reported as occurring in large quantities in a porphyritic rock. The opal found at the surface is mostly chalcedonic, but some true precious opal has been obtained, and small stones have been cut from pieces of it.

IDAHO.

An extensive and promising opal locality is announced in Idaho, and is described in a letter from Mr. S. V. LeSieur, of Provo, Utah, who discovered it in May, 1902, and made further investigation of it later in the year. The locality is in Lemhi County, Idaho, on Panther Creek, on the west side of the valley, some 6 miles below its head, and at an altitute of 7,000 feet. Here a large dike of porphyry runs parallel with the creek for nearly a mile and a half, forming a ledge partly covered with overwash from the mountain slope, but at times outcropping and rising several feet. The width of the dike is estimated at as much as 150 feet; and the porphyry is full of opals of all kinds, qualities, and colors—milky, blue, green, brown, pink, etc.—and among them some of the perfectly transparent variety, the "fire" or flame opal. Many of the masses are large, but to obtain good-sized stones from them is difficult, as the opals are very brittle and the rock very hard. He succeeded in getting an opal of 60 carats which showed green reflections, and a brown opal of 150 carats, but otherwise no really fine stones above 10 carats weight. The opal here is largely of the glassy variety, with broad "flames" of color—a kind that is fragile and not well suited for jewelry. Its value as a mine for gem material, in view of the large proportion of loss by breakage, remains to be determined.

What must probably be the same locality was briefly mentioned in the report of this Bureau for 1895, on the authority of Mr. Don Maguire, of Ogden, Utah, but no subsequent references to it have appeared, and no development seems to have been made until now.

NEW SOUTH WALES.

The search for opals is still being carried on with as much interest as ever in the White Cliffs field of New South Wales. More than twenty claims are being worked for opal, and competition for the gem in open market is brisk, good specimens being sold for from $150 to $200 per ounce, although quite frequently less than that is paid for a quantity weighing many pounds.

Among the many kinds and large quantities of opal recently discovered and worked in New South Wales and other parts of Australia, there is a large amount of material that is very beautiful but not available for cutting into gems for setting, and much ingenuity has been shown in devising ways for utilizing this otherwise discarded material and bringing it into the arts in new forms of ornamental work. When the flake is too thin to cut a gem, it is cemented on one side to a piece of black oynx, producing a more brilliant effect than would the opal itself. If the flake is much thicker, this is sold as opal appliqué. When the opal is in smaller pieces, it is cemented as a mosaic upon slate or black onyx, producing an effect of great beauty. Still further, minute particles of opal are put into sealed tubes of glass or rock-crystal filled with liquid glass, and the liquid glass solidifying makes the whole seem one homogeneous mass of rock crystal and opal, and produces a brilliant object adapted for use as handles for parasols or canes.

A correspondent of the London Mining Journal, writing from Sydney in October, 1902, reports great prosperity and progress in the opal mining in the White Cliffs district. A number of new mines have been opened and prospectors are actively engaged on the outskirts of the region. Some very rich patches of beautifully colored opal have lately been discovered. German buyers are now visiting the field and purchasing largely. It seems that art jewelry is receiving much attention in Germany, and that Australian opal is coming into high favor for such work, particularly for hair ornaments, brooches, etc. As many as two hundred men are now employed at one of the leading mines—that known as Barratt's Block 25.

Dr. Card[a] reports opal, a translucent chrome-green variety, a beautiful stone admitting of a fine polish, from Port Macquarie; amygdules of precious opal in melaphyre, near Ballina; and rhodonite, massive, with magnetite, 8 miles north of Lyndhurst, and also in various districts of New England, New South Wales.

QUEENSLAND.

The existence of precious opal in Queensland has been known for many years, but the first mining activity was about 1878. Of late the rich production in New South Wales has attracted more attention; and although severe droughts have interfered with working and prospecting, yet a large amount of fine opal has been obtained. The estimated value of the product for the twelve years from 1891 to 1901, inclusive, is £131,000, about one-third the amount estimated for New South Wales.

The Queensland opal field was briefly described in the report of this Bureau for 1895. A very full account of it has appeared within the last year by Mr. C. F. V. Jackson, assistant Government geologist.[b] The opaliferous district extends from the southern border of Queensland nearly to latitude 21° south, between east longitude 141° and 146°. It is interesting to compare this report with that elsewhere noted

[a] Record of the Geological Survey of New South Wales for 1902, vol. 2, pt. 2, pp. 29–46.

[b] The opal mining industry and the distribution of opal deposits in Queensland: Report Queensland Geol. Surv. No. 177; 8vo., 34 pp., with map; Brisbane, 1902.

(p. 34), on the Queensland sapphire deposits, which lie about 1 degree east of the middle portion of this area, but are separated from it by the great dividing range of mountains. Many of the geological features are very similar, but there seems to be no indication of either gem in the territory of the other.

The mode of occurrence is the same as in New South Wales (see descriptions of the latter in the reports of this Bureau for 1896, 1898, and 1901), but the precise geological relations are more exactly given in this recent account. The rock in which the opal has been deposited consists of the remains of a formation, once widely extended but now largely removed, known as the Desert Sandstone. This rock is Upper Cretaceous, and rests somewhat unconformably upon the Rolling Downs formation (Lower Cretaceous), which was laid down by a narrow sea that extended from the great bight on the south to the Gulf of Carpentaria on the north, dividing Australia into two islands. The Desert Sandstone was deposited during a period of less extensive depression following one of partial elevation. It is fragmental in character, of no great thickness, and consists of a lower body of soft and clayey deposits, and an upper portion that is siliceous and extremely hard. It is in the lower part of this latter, just above the softer portion, that the opaliferous zone or "band" occurs. Much of this intensely hard siliceous capping is strewn over the country in more or less rounded pieces, called "water dogs" by the miners, apparently identical with the "billy" of the sapphire district (see notice above, p. 35).

Opal is found occasionally in pieces and fragments on the surface, coming from decomposition of the rock, but this is not common, and there are in general no surface indications. Hence the mining is a haphazard affair, as the "band" may be rich or poor at any particular point where an opening is made down to it. The work is done usually with a pick, as blasting is found to shatter the opal too much. In many cases, Mr. Jackson says, exploratory drives are abandoned—quite too soon, in his opinion—before reaching the level of the "band," if the indications are not favorable in the overlying rock.

The rock matrix is a hard ferruginous sandstone, or siliceous ironstone, at times forming concretions, which lie in clayey sandstone so as to look like a conglomerate. These concretions, from a fraction of an inch up to 6 or 8 inches in thickness, have evidently been formed from the outside, and their centers are occasionally hollow, or contain a clear liquid or a white powder, but more generally they are filled with opal, common or precious, which at times extends in veins or strings into the outer layers. In other cases the "bowlders" are very much larger, and the opal is not present as a nucleus, but in seams and layers between the concentric shells of the concretions or traversing them in veins or cracks. At one or two places the pure opal forms little irregular concretionary masses in clay, and at others it occurs in "pencils" or "pipes," which are apparently stems or small trunks of plants replaced by silica; these are in the sandstone, and have much geological interest. All these accounts are very similar to those above referred to in the reports of this Bureau as to New South Wales.

There is a great area of opal-bearing country and a great variety and beauty of the material, but the aridity is such as frequently to compel the miners and prospectors to suspend work. Some of the miners cut their own opals and polish them, but rather poorly and wastefully. Mr. Jackson treats of the uses of the material; much that is very elegant is rejected because not fit for cutting the conventional rounded stones, and he hopes that the growing taste for more artistic work in precious stones may utilize much of this heretofore discarded material. The precious opal forms about one-tenth of that obtained, the rest being common opal of all kinds and colors.

At one or two localities near Springsure, and at a few points in other parts of Australia, opal occurs in its usual manner in the cavities of a trachyte. These have not been worked, however, to any extent as yet.

WEST AUSTRALIA.

The precious opal, so widely occurring in New South Wales and Queensland, as elsewhere referred to here (pp. 58–59), has not been found in West Australia, but a peculiar association of common opal with a silicified crocidolite, similar to that of South Africa, is described[a] from Yarra Yarra, in the northwest district of the colony, by Mr. Edward S. Simpson, mineralogist to the geological survey. In a letter to the writer, Mr. Simpson states that the common opal is yellow, brown, and green, in varying shades, and is traversed by small veins of the crocidolite. This crocidolite is chiefly brown with a golden chatoyancy, but is sometimes dark green with an almost white chatoyancy, and occasionally brownish-red with a reddish-amber chatoyancy. The two first-named kinds recall strongly from the description the two African types, corresponding respectively to a complete or partial alteration of the original crocidolite.

TURQUOISE.

ALABAMA.

Turquoise has been discovered in a new and hitherto unsuspected region, namely, in the middle eastern part of Alabama, at several points near Idaho, Clay County, about 95 miles due east of Birmingham, in the region of the Talladega Mountains. Some copper mines

[a] Simpson, Edward S., Rept. Geol. Survey Western Australia No. 6, pt. 3 p. 89, Perth, 1902; and in a letter.

were previously located in this vicinity. The turquoise seems to be of two distinct varieties—one, yellowish-green, occurring in compact veins from one-eighth to three-fourths of an inch in thickness, and resembling much of the New Mexican material, which frequently improves in color at a greater depth; the other is a bluish variety penetrating a gray matrix in all directions in seams spreading out from an eighth of an inch thick to the thinness of paper. The color, however, is more blue and the occurrence more distinctly resembles that of the Persian material.

One of the localities has been mined somewhat. The main mine was discovered accidentally by the finding of a piece of turquoise on the surface. Then an opening was made, and a considerable quantity of material was obtained, but no regular mining has yet been done. Unlike the western localities, there are no traces of aboriginal workings, according to Prof. Eugene A. Smith, the State geologist, nor have any objects made from turquoise been used among the recent Indians, nor has turquoise been found in their graves.

The geological relations of these deposits have not thus far been investigated.

ARIZONA.

In a recent paper upon the "Racial unity of the historic and prehistoric people of the Southwest, and particularly of New Mexico and Arizona," presented at the meeting of the "International Congress of Americanists," New York, December, 1902, by Prof. William P. Blake, Territorial geologist and professor at the University of Arizona, a delegate from that Territory, attention was especially directed to the very general distribution of fragments of the mineral known to the existing tribes as chalchuite in the ancient ruins throughout Arizona. "It occurs generally in the form of discoidal beads and tabular pendants, but often as mosaics. * * * There are several localities of this gem in Arizona and New Mexico, exhibiting extensive prehistoric mining. Old pits are found partly filled with débris and stone tools. * * * The identity of chalchuite with turquoise was shown by me in 1857. It has been claimed by some, notably by the late E. G. Squier, that the word 'chalchuite' means simply a green stone and is equally applicable to jade or to other green stones; but the fact that the Indians of to-day apply this name to the native turquoise only supports my contention that it has been so applied from prehistoric periods to the present, and that it does not refer to 'jade, or jasper,' or other ornamental stones."

Professor Blake has some very strong grounds for his view, which identifies the chalchuite with the New Mexican turquoise; but on the other hand, there is equally good evidence that much of the ancient chalchihuitl was jade, as has recently been shown by the researches of

Mrs. Zelia Nuttall, who has traced the geographical distribution of chalchihuitl as given in the earliest records of the Spanish conquest, and in the tribute rolls of Montezuma.[a] It seems very clear that the view of so eminent an archæologist as the late Mr. Squier is in the main correct, that the word denoted a highly valued green stone, with no exact mineralogical distinction. But we may now recognize that the name was applied especially to jade in southern Mexico and to turquoise in northern Mexico—the two stones occurring in those regions, respectively, and neither region possessing the other stone. The old records, the Spanish narratives, the ancient workings, and the still lingering traditions, are abundantly clear as to the two minerals meant by chalchihuitl in the two different sections of the country.

CALIFORNIA.

Further discoveries of turquoise are reported by Mr. C. R. Orcutt, of San Diego, Cal., at various points in the Mohave Desert in that State, not far from Victor, San Bernardino County. No particulars are given, and the announcement is merely put on record, until further accounts are received.

GERMANY.

THURINGIA.

A new locality for turquoise is reported in southern Thuringia.[b] It is located in the siliceous slate quarry among strata of middle Silurian age, near the highway between Weckersdorf and Langenwolschendorf in the dukedom of Reuss. The mineral occurs in slender bands, sometimes much elongated, evidently representing fillings of cavities.

APATITE (MOROXITE).

SOUTHWEST AFRICA.

Some blue-green crystals were obtained in a decomposed feldspar of a coarse-grained granite, on the river Swakop, southwest Africa, that were supposed to be sapphires. Dr. C. Klein,[c] of Berlin, found upon a careful examination that they were not such, but that from their hardness (5), specific gravity (3.2), hexagonal form, and glassy luster, they were really apatite of the moroxite variety, a mineral that, under its many strange occurrences of color and forms of crystal, has been at times mistaken for a variety of other minerals.

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[a] Nuttall, Zelia, Chalchihuitl in Ancient Mexico: Am. Anthropologist, vol. 3, 1901, pp. 227-238.

[b] Zeitschr. f. Naturw., vol. 72, pt. 6, July, 1900, p. 453. Neues Jahrbuch f. Min., Geol. und Pal., 1902, vol. 1, pt. 2. Mineralogie, Einzelne Mineralien, p. 187.

[c] Centralblatt für Min., Geol., u. Pal., Berlin, Oct. 23, 1902, No. 24, p. 748.

LAZULITE.

MADAGASCAR.

In the last report of this Bureau[a] an abstract was given of the account published by M. Lacroix of the gem minerals of Madagascar. Among those mentioned very briefly, yet as of possible value, was klaprothite (lazulite). In a more recent article,[b] M. Lacroix describes specimens of this mineral lately received by him from two localities in the island. Some of these were from Mount Bity and were found in the soil associated with the colored lithia tourmalines described in the last report. In their richness of color and their transparency in thin laminæ they resemble the lazulite from the diamond gravels of Minas Geraes in Brazil. They present fragments of crystals of 6 to 8 centimeters in diameter, which are attached to small portions of quartz and muscovite, and apparently came from quartz veins. The other specimens are from a different region, northeast of Betafo, and present a curious association—a rock composed of deep-blue lazulite and colorless cyanite, with small quantities of quartz, muscovite, tourmaline, sphene, and magnetite, finely mingled. This singular rock occurs in a region of pyroxenic and amphibolic gneiss, and is comparable only to a somewhat similar rock from Horrsjoberg, in Wermland.

AMBER.

ROUMANIA.

In a dissertation published at Bucharest[c] on the amber localities of Roumania, the author, Mr. G. Muntuanu-Murgoci, gives a general discussion of fossil resins with particular reference to the Roumanian amber, for which he indicates no less than forty-four important localities, which are shown on the map accompanying his paper.

These localities he divides into two sets, which are termed primary and secondary. The primary occurrences are in the Upper Eocene and in the Oligocene (menilite limestone), where the amber is associated with lignite. In consequence of this distribution the layers of amber are closely connected and directed by the formations of the southeast Carpathians. The secondary occurrences are in the Miocene (salt formation) and in alluvial deposits.

Although the Roumanian amber is not important to the country from an industrial standpoint, yet it is a valuable decorative product. Its color is usually dark red to brown; much of it is translucent, though

[a] Mineral Resources U. S. for 1901, U. S. Geol. Survey, 1902, p. 768.

[b] Bull. Soc. franç. de Min., vol. 25, Nos. 4-5, April-May, 1902, p. 115.

[c] Muntuanu-Murgoci, G., Zacemintale Succinului din Romania [The amber localities of Roumania], graduation dissertation, 56 pp., 6 illustrations, 1 map: Bucarest, 1902.

it frequently contains impurities. The Roumanians prize it very highly for ornamental uses, and value it much above the amber of the Baltic.

The publication contains an exhaustive and critical treatise on resins in general and the Roumanian localities in particular.

JET.

YORKSHIRE, ENGLAND.

A recent examination of sections of jet from Yorkshire leads Mr. A. C. Seward[a] to believe that the origin of jet is from the alteration of coniferous wood, and, in part, of wood of the Araucarian type. Sections from specimens which consist partly of petrified wood and partly of jet show a gradual passage from Araucarian wood to a pure jet which retains little trace of its ligneous origin.

GRAPHIC GRANITE.

URAL MOUNTAINS.

Graphic granite, or Hebrew stone, as the coarsely intertwined crystallization of quartz with feldspar is called, presents, when polished across the crystals themselves, a marked likeness to Hebraic characters. This substance is extensively polished in Russia and worked into beautiful art objects and sometimes into charms. It is found at various localities, but especially in the Ural Mountains, and many of the finest art productions of that region are made from it.

In a recent article[b] Prof. A. Karpinsky, of St. Petersburg, describes an examination of the graphic granite from Mursinka, in the Ural, and particularly of some specimens in which the feldspar crystals (orthoclase) are well preserved, but the quartz has entirely disappeared, leaving cavities which bear on their sides impressions of the striæ of quartz prisms. Similar specimens have been found at other localities in the Urals. Professor Karpinsky thinks that these traces of quartz prisms in the cavities disprove the statement of Noegbom,[c] that the silica was removed during the period of crystallization, and that water free from carbonic acid could, perhaps, dissolve the quartz more readily than the orthoclase. There is no evidence that any pseudomorphous alteration has occurred, as both Russian and Swedish specimens are known in which the quartz is partially removed, with no trace of pseudomorphism.

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[a] Seward, A. C., On the structure and origin of jet: Rept. Brit. Assoc. Adv. Sci. for 1901, pp. 856-857, London.

[b] Proc. Imp. Russ. Min. Soc., vol. 39, 1902, Prot. p. 23.

[c] Bull. Geol. Inst. Upsala, vol. 3, 1897, p. 436.

THE GEM-CUTTING INDUSTRY.

UNITED STATES.

Diamond-cutting industry in the United States.—In the brief period of ten years during which the diamond-cutting industry has been conducted on a commercial basis in the United States, it has advanced with such rapid growth that this country now commands a foremost position among the diamond-cutting countries of the world. The importation of $7,000,000 worth of rough diamonds during the twelve months ending June 30, 1903, evidences the growing prosperity of this industry here; and had not the rough diamond stock of the world been materially reduced by the demand exceeding the supply, it is probable that the United States would to-day be exporting polished diamonds to Europe instead of importing from there the additional quantities necessary to supply our demand. The effect of such a condition can be better appreciated when attention is called to the fact that out of about $19,000,000 worth of diamonds imported through New York City into this country during the fiscal year ending June 30, 1903, fully $8,000,000 represented wages paid to foreign laborers. Upon the $7,000,000 worth of rough diamonds imported during the fiscal year ending June 30, 1903, there is represented a saving to this country of over $3,000,000 paid to its own workmen. Upon this basis it is safe to estimate the saving in labor to this country in this industry alone during the last five years to be over $10,000,000; it has both given remunerative employment to many men and also kept this large sum of money in this country.

The ingenuity and enterprise of the American cutters have been material factors in their success. In Amsterdam, the acknowledged home of the industry, where it has been conducted for more than one hundred years, no innovations have been introduced. It has been left to the Americans to introduce a number of new mechanical labor-saving devices, which have unquestionably given them a great advantage over the European cutters, where diamond cutting is done by the ancestral "rule of thumb" handed down from father to son.

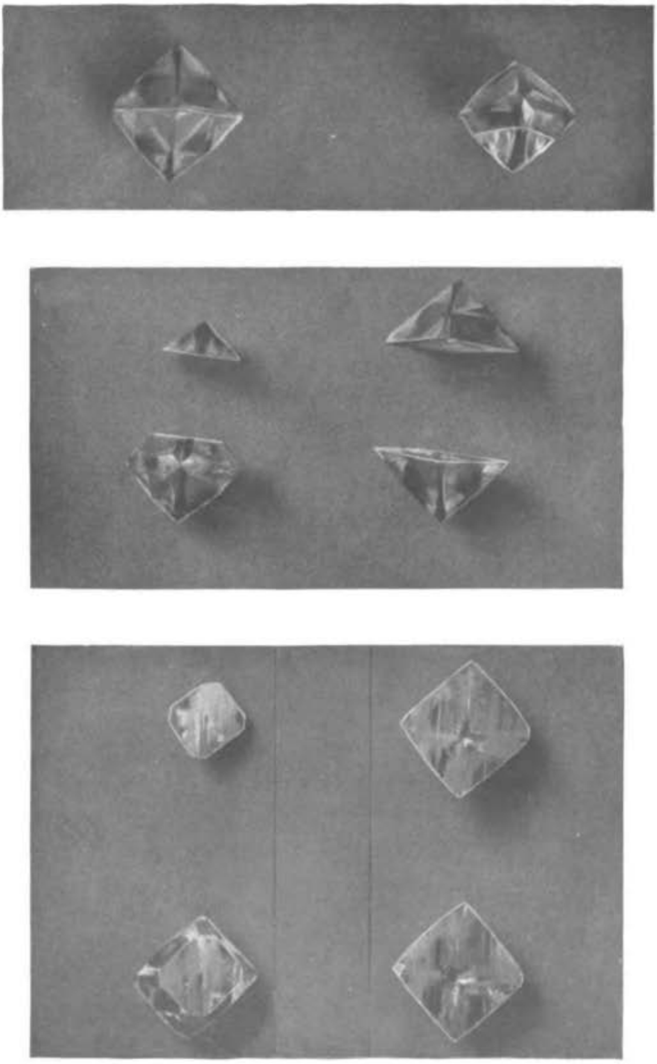
The banking system in Holland seems to be favorable to the diamond industry, but there is a greater supply of ready money in this country to conduct the industry, individual diamond-cutting firms importing fully $1,000,000 worth of rough stones.

In the early part of 1903 there seems to have been great difficulty in obtaining the rough diamonds, due both to the great demand for diamonds and to the fact that the output has not increased, owing either to the lack of capacity to supply a greater demand or to the regulation of supply by the De Beers Mines Company.

About nine days elapse from the time of shipment until the rough diamonds are received in New York, and as rough diamonds are not dutiable the shipments are made and cleared with great rapidity.

No small diamond-cutting establishments can exist at present unless they do only recutting or repairing work, as the diamond syndicate sells only in "series," as the parcels of rough diamonds are called. These parcels or series are made up of many varieties of diamonds known by the trade names of "bye-waters," "capes," "fine capes," "silver capes," and "crystals." Each series is made up of individual parcels of each of the above-named varieties, each parcel representing a proportion of these qualities as they are found in the mine. In other words, the series is made up so that when a dealer buys a "series," he buys every quality of diamond found in the mine in the proportion in which they are produced at that time. The individual diamonds in each of these several parcels weigh from 1 to 20 carats in their natural, rough, uncut condition. The finished stones contain only from 40 to 60 per cent of these weights; that is, from 40 to 60 per cent is ground and polished away in the various cutting processes. The principal new processes carried on in this country are sawing and splitting diamonds by means of grooving or notching them, and may be described as follows:

Sawing diamonds.—The process of sawing diamonds, whereby it is possible to saw in two, at the central part or girdle, an octahedron (known as six-point) or a long stone, or to remove an imperfection that it was impossible to cleave at a given point, has now come largely into use in the United States, and also at Antwerp and Amsterdam. This is especially true of the United States and Antwerp, where the larger diamonds are cut, and to a less extent of Amsterdam, where the smaller stones, known as mele, are more used; although there is no patent law in Holland to prevent its introduction. The invention, or inventions, are by Americans, and call to mind the old method of sawing the larger gems by means of small, flat lead strips, or saws, such as were used when the Regent diamond was cut in 1750. At that time thin strips of lead charged with diamond dust were employed; these were rarely drawn more than once across the stone. The great advantage of the new method will be appreciated when it is understood that thereby it is made possible to cut a 6-carat crystal in two along the best line to place the main table-faces of the two stones thus produced. One patentee claims the process of sawing off only the parts desired to be removed; the other makes a special claim that the dividing of the diamond at the girdle is an original claim apart from the former. The methods consist in holding the diamond firmly and very steadily under pressure against a rapidly revolving disk of sheet iron, or "phosphor" bronze. The wheels are much like those used in sawing thin sections for microscopic rock sections or for cutting jade, rock-crystal, and other hard stones. It is claimed that in thus dividing an octahedron at the center or girdle as little as 2 per cent of the weight of the crystal is lost—a great saving



DIAMOND SAWING.

of material. As evidencing the wonderfully keen responsive business acumen which has always characterized the "rough" syndicate, the price of all rough diamonds that could be improved or advanced in value by such sawing was immediately advanced when the process became known.

More recently certain expert cleavers, as they have been called, found that they could remove an occasional part of a diamond, such as the angle of an octahedron, by nicking the stone at a given point, and then by a sharp blow breaking off a piece, saving both the material and the time that would have been lost in removing the edge or piece by polishing.

Grooving diamonds.—A patent has been granted for a new process of grooving diamonds, these gems of course being also polished, and the claim is made that the grooving insures a greater brilliancy. The diamonds are sometimes cut with perfectly parallel grooves around a stone having eight, ten, twelve, or eighteen sides. The grooving is also applied to the facets of the brilliants, especially in the new forms of cutting in which the pavilion of the stone is entirely replaced by rose-cut facets; and the hollows of the concave grooves are as bright as the other faces. A diamond of any shape can be polished by this method.

New "dop" for diamonds.—Considerable attention has been given to a new dop that holds the diamond while it is being cut and polished. This instrument grasps the diamond in claws and holds it while it is undergoing the polishing process, thus doing away with the need for securing the diamond in place by means of a fusible metal which requires heating many times in the handling of a single stone, with the attendant risk of injuring the stone by the repeated heating. These dops have mechanical devices so arranged that a set of facets can be adjusted and cut on a diamond by a single setting of the diamond in the dop.

PRODUCTION.

In the following table is given a statement of the production of precious stones in the United States from 1896 to 1902, inclusive:

Production of precious stones in the United States, 1896–1902.

Stone.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
Diamond	None.	None.	None.	$300	$150	$100	None.
Sapphire	$10,000	$25,000	$55,000	68,000	75,000	90,000	$115,000
Ruby	1,000	None.	2,000	3,000	3,000	500	None.
Topaz	200	None.	100	None.	None.	None.	None.
Beryl (aquamarine, etc.)	700	1,500	2,200	4,000	11,000	5,000	4,000
Emerald	None.	25	50	50	4,000	1,000	1,000
Phenacite	None.	None.	None.	None.	None.	None.	None.
Tourmaline	3,000	9,125	4,000	2,000	2,500	15,000	30,000
Peridot	500	500	500	500	500	500	500
Quartz, crystal	7,000	12,000	17,000	12,000	10,000	10,000	12,000
Smoky quartz	2,500	1,000	1,000	None.	1,000	1,000	2,000
Rose quartz	500	None.	100	100	100	150	200
Amethyst	500	200	250	250	500	500	2,000
Prase	100	None.	None.	None.	None.	None.	None.
Gold quartz	10,000	5,000	5,000	500	2,000	2,000	3,000
Rutilated quartz	500	None.	100	50	50	50	100
Dumortierite in quartz	50	None.	None.	None.	None.	None.	None.
Tourmalinated quartz	None.	None.	None.	None.	None.	1,000	None.
Agate	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Moss agate	1,000	1,000	1,000	1,000	1,000	500	500
Chrysoprase	600	None.	100	100	100	1,500	5,000
Silicified wood (silicified and opalized)	4,000	2,000	2,000	3,000	6,000	7,000	7,000
Opal	200	200	200	None.	None.	None.	150
Garnet (almandite)	500	7,000	5,000	5,000	500	100	None.
Rhodolite	None.	None.	None.	None.	20,000	21,000	1,500
Garnet (pyrope)	2,000	2,000	2,000	2,000	1,000	1,000	1,000
Topazolite	100	None.	None.	None.	None.	None.	None.
Amazon stone	1,000	500	500	250	250	200	500
Oligoclase	500	25	10	20	20	None.	None.
Moonstone	250	None.	None.	None.	None.	None.	None.
Turquoise	40,000	55,000	50,000	72,000	82,000	118,000	130,000
Utahlite (compact variscite)	500	100	100	100	100	250	None.
Chlorastrolite	500	500	5,000	3,000	3,000	3,000	4,000
Mesolite (thomsonite, so called)	500	500	1,000	1,000	1,000	1,000	1,000
Prehnite	100	100	100	50	50	None.	None.
Diopside	200	100	None.	None.	None.	None.	None.
Epidote	250	None.	None.	None.	None.	None.	None.
Pyrite	1,000	1,000	1,000	1,000	2,000	3,000	3,000
Malachite	None.	None.	None.	250	200	100	None.
Rutile	100	600	110	200	100	None.	None.
Anthracite (ornaments)	2,000	1,000	1,000	2,000	2,000	2,000	2,000
Catlinite (pipestone)	3,000	2,000	2,000	2,000	2,000	2,000	2,000
Fossil coral	1,000	500	500	50	50	100	None.
Arrow points	1,000	1,000	1,000	1,000	1,000	500	None.
Total	97,850	130,675	160,920	185,770	233,170	289,050	328,450

IMPORTS.

The following table shows the value of the diamonds and other precious stones imported into the United States from 1867 to 1902, inclusive:

Diamonds and other precious stones imported and entered for consumption in the United States, 1867–1902.

Year ending—	Diamonds.					Diamonds and other stones not set.	Set in gold or other metal.	Total.
	Glaziers'.	Dust.	Rough or uncut.	Set.	Unset.			
June 30—								
1867	$906					$1,817,420	$291	$1,818,617
1868	484					1,060,544	1,465	1,062,493
1869	445	$140				1,997,282	23	1,997,890
1870	9,372	71				1,768,324	1,504	1,779,271
1871	976	17				2,349,482	256	2,350,731
1872	2,386	89,707				2,939,155	2,400	3,033,648
1873		40,424	$176,426			2,917,216	326	3,134,392
1874		68,621	144,629			2,158,172	114	2,371,536
1875		32,518	211,920			3,234,319		3,478,757
1876		20,678	186,404			2,409,516	45	2,616,643
1877		45,264	78,033			2,110,215	1,734	2,235,246
1878		36,409	63,270			2,970,469	1,025	3,071,173
1879		18,889	104,158			3,841,335	538	3,964,920
1880		49,360	129,207			6,690,912	765	6,870,244
1881		51,409	233,596			8,320,315	1,307	8,606,627
1882		92,853	449,513			8,377,200	3,205	8,922,771
1883		82,628	443,996			7,598,176	[g]2,801	8,126,881
1884	22,208	37,121	367,816			8,712,315		9,139,460
1885	11,526	30,426	371,679			5,628,916		6,042,547
Dec. 31—								
1886	8,949	32,316	302,822			7,915,660		8,259,747
1887	9,027	33,498	262,357			10,526,998		10,831,880
1888	10,025	29,127	244,876			10,223,630		10,507,658
1889	8,156	68,746	196,294			11,704,808		11,978,004
1890	147,227	179,154	340,915			[e]12,429,395		13,105,691
1891	[a]565,623	125,688	(c)			[f]12,065,277		12,756,588
1892	532,246	144,487				[f]13,845,118		14,521,851
1893	357,939	74,255				[f]9,765,311		10,197,505
1894	82,081	53,691				[f]7,291,342		7,427,214
1895	107,463	135,558				[f]6,330,834		6,573,855
1896	78,990	65,690		(d)	(d)	[f]4,474,311		4,618,991
1897	[b]29,576	167,118	1,386,726	$330	$2,789,924	1,903,055		6,276,729
1898	8,058	240,665	2,513,800	6,622	5,743,026	1,650,770		10,162,941
1899	2,428	618,354	4,896,324	13,388	8,795,541	2,882,496		17,208,531
1900	8,333	605,495	3,658,645	10,721	7,803,066	1,472,328		13,561,588
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

[a] Including also engravers', not set, and jewels to be used in the manufacture of watches, from 1891 to 1894; from 1894 to 1896 miners' diamonds are also included.
[b] Including also miners' and engravers', not set.
[c] Included with diamonds and other stones from 1891 to 1896.
[d] Not specified prior to 1897.
[e] Includes stones set and not specially provided for since 1890.
[f] Including rough or uncut diamonds.
[g] Not specified since 1883.