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PRECIOUS STONES.

By Douglas B. Sterrett.

INTRODUCTION.

Interest in the mining in the United States of the more valuable of the precious stones, as the diamond, ruby, emerald, and sapphire, was keen during 1907. The announcement of the discovery and the statement of the incidents associated with the discovery of diamonds in Arkansas were made during the year by Messrs. Kunz and Washington. Development work on this diamond deposit was carried on and is still in progress. The ruby deposits of Cowee Valley, Macon County, N. C., were still further tested, and promising ruby in matrix specimens was reported as found. Prospecting for emerald at the emerald hiddenite mine in Alexander County, N. C., resulted in the discovery of promising gems, and it is expected that the locality will be developed on a larger scale in the near future. The output of sapphire in Montana, of both the rich blue and the varicolored gems, was very large. The blue sapphire is found in the matrix in a dike; the varicolored sapphire is found in placer deposits. At one locality the latter variety was mined with a dredge along with gold.

Several new localities and varieties of gems have been reported during the year. Among the new discoveries are deposits of topaz near Streeter, Mason County, Tex., and of beryl, tourmaline, garnet, and rose-quartz in Colorado. Among the new varieties of gems are benitoite, blue chrysoprase, serpentine cat's-eye, blue and green gold quartz, and smithsonite. Benitoite is a sapphire-blue colored stone found in San Benito County, Cal. Blue chrysoprase is copper-stained chalcedony, and has been found at Globe, Ariz. Serpentine cat's-eye has been found in Tulare County, Cal. It is gray to green serpentine with a silky luster, and gives a marked cat's-eye effect when cut "en cabochon." A new variety of gold quartz consists of native gold liberally sprinkled through copper-stained vein quartz. The new smithsonite is a translucent, apple-green variety found in large quantities in the Kelly mine, New Mexico. The color is similar to that of chrysoprase, though the gem is much softer.

Old gems appearing under new names are amatrice (utahlite matrix) and azurmalachite. Amatrice is the green, blue-green, and bluish variscite or utahlite cut with its associated matrix. The latter varies from white to gray, yellow, red, purplish, and brown in color, and the various combinations obtained in cut gems are quite pleasing. Azurmalachite is the name applied by Dr. G. F. Kunz to the copper carbonate gems from the copper mines of Arizona, and, as the name indicates, is a combination of azurite and malachite.

The precious-stones industry was in a flourishing condition during the first part of 1907. During the last half of the year, however, there was some depression in mining and the sale of gems. The native mining part of the industry was not so heavily affected as the part dependent on imported material.

AGATE, MOSS AGATE, ETC.

Agate or chalcedony "clams" were reported from South Bend, Wash., by the Haberl Lapidary and Jewelry Company. Whether these are petrifactions or mammillary deposits the writer is not certain. They are said to contain globules of water. Several thousand pounds of moss agate were reported by Mr. W. C. Hart from the Hartville mining district of Wyoming. Dr. George E. Ladd reports the occurrence of agate and other chalcedony minerals in southeast Missouri. They occur abundantly in the residual soil over limestone formations, and some handsome specimens are found.

Mr. A. E. Heighway mentions the occurrence of agate, apparently of suitable quality and in sufficient quantity to be of commercial value, at two localities in the province of Santiago, Cuba. One of these is about 7 miles south of Bayamo; the other is about 2 miles southeast of Jibacoa, a town about 16 miles southeast of Manzanillo.

Comparatively few agate and chalcedony gems are cut or polished in the United States, the bulk of these minerals being cut at Oberstein, Idar, and other towns in Germany. The agate-cutting industry in Oberstein dates back to the fifteenth century, from which time it flourished until the close of the eighteenth century. With the exhaustion of the native deposits of agate, a decline followed until 1830, when new supplies were obtained from Brazil, and from that time until the present the industry has flourished, though scarcely any native agate is now used.

AMAZON STONE.

The production of amazon stone came principally from Colorado, with a small quantity from Pennsylvania. In Colorado part of the output was obtained from the vicinity of Pikes Peak and part from Florissant, also in Teller County. Mr. J. D. Endicott reports the discovery in Custer County, Colo., of a new deposit of amazon stone, which has not yet been opened.

AMBER.

BURMA.

The production of amber from the Myitkyina district of Burma in 1906 was 217 hundredweight, valued at £709,[a] as against 126 hundredweight, valued at £945, in 1905. According to Consul-General W. H. Michael, of Calcutta,[b] the Burmese amber is in good demand. Its rich color, hardness, and the high polish it takes render it suitable for making into beads for rosaries and necklaces. Mining for amber by the Burmese is done in a crude way, and generally after the harvest work is completed. The men dig down, near places where amber has been found, sometimes to a depth of 45 feet; and then if no amber is found, a new trial is made elsewhere.

[a] Rec. Geol. Survey India, vol. 36, pt. 2, 1907. [b] Daily Cons. Repts., July 26, 1907.

GERMANY.

A large block of golden yellow amber, about 5 inches long, 4 inches wide, and 3 inches high, weighing 33 ounces, is reported to have been found on the beach at Thiessow, Pomerania.[a] It is said to be free from cracks or flaws.

AMETHYST.

There was a small production of amethyst in 1907 from scattered localities. The largest output came from Nelson County, Va., with smaller quantities from Amherst County in the same State, Iredell and Macon counties, N. C., Rabun County, Ga., Fremont County, Colo., and Maine.

In Macon County, N. C., amethyst has been found at various places in the region of Tessentee Creek, near Scaly Mountain, and to the south of Highlands. In Rabun County, Ga., a few miles to the south of the last-named localities, amethyst has been found at several places within 2 or 3 miles of Clayton and from 12 to 15 miles to the east. The amethyst of this region occurs in veins cutting granite gneiss and mica gneiss. The veins in which the amethyst occurs are generally irregularly filled, well-defined fissures cutting the inclosing rocks at variable angles, though generally with a high dip. Some of these veins have been traced several hundred feet. Deep-colored amethyst crystals are found in pockets in these veins, often associated with pale amethystine and colorless quartz crystals. The spaces between the crystals are commonly filled with red clay or other earthy material. The pockets range from a fraction of an inch to 15 or 18 inches in thickness, and may extend several feet along the vein. The crystals range in size from a small fraction of an inch to 3 and 4 inches across. In some of the crystals the purple color of amethyst is entirely lacking or present only in pale shades. In others the rich purple of Siberian amethyst is present. The color is generally most intense near the points of the crystals and often occurs in planes parallel to the crystal faces. This renders only portions of the crystals suitable for cutting, although much amethyst and quartz suitable for specimens only is obtained.

The production of amethyst from Colorado was reported from a new deposit discovered by Mr. J. D. Endicott, of Canon City. This deposit is near Parkdale, about 13 miles west of Canon City. Mr. Endicott describes the vein as 30 inches wide, striking northwest, with a nearly vertical dip, through decomposed granite. The crystals of amethyst and amethystine quartz range in size up to 2 inches thick and 3 inches long.

AZURMALACHITE.

The name azurmalachite has been applied by Dr. George F. Kunz to the gems cut from blue azurite combined with green malachite.[b] This form of gem is found in the copper mines of Bisbee and other districts in Arizona. The combination of minerals occurs in a variety of different forms, as concentric layers in stalactites, and as globular and botryoidal masses, etc. Various effects result from cutting in different directions through the masses, and attractive

[a] Manuf. Jeweler, April 2, 1908. [b] Eng. and Min. Jour., August 17, 1907.

cuff buttons, scarf pins, hat pins, and other stones for less expensive jewelry are thereby obtained. Some of this gem was found at Yerrington, Nev., during 1907.

BENITOITE.

Benitoite is a new gem mineral from California from the Mount Diablo range near the San Benito-Fresno county line. The gem has a blue color and was first mistaken for sapphire when discovered early in 1906 by Messrs. Hawkins and Sanders. The following notes are taken from a description of the physical and chemical properties of the stone by Messrs. George D. Louderback and Walter C. Blasdale,[a] and from a description of the geological occurrence by Ralph Arnold.[b]

Benitoite is regarded as an acid titano-silicate of barium with the formula $BaTiSi_3O_9$. It fuses quietly to a transparent glass at about 3, the fusing point of almandine garnet. Though practically insoluble in hydrochloric acid, it is readily attacked by hydrofluoric acid and dissolves in fused sodium carbonate. Its hardness is above 6, probably between 6¼ and 6½, and its specific gravity is 3.64–3.65. Benitoite crystallizes in the hexagonal system, trigonal division. The common forms observed are the basal plane, positive and negative trigonal pyramids, and corresponding prisms. The common habit is pyramidal, though occasionally the base is well developed and the crystal tabular. No tendency toward a prismatic habit was observed. The refractive index is a little above sapphire, or about 1.77 for the ordinary ray and 1.80 for the extraordinary ray. The double refraction is therefore strong. The color of benitoite varies from deep blue with a violet tint to pure blue of a lighter shade; small crystals are sometimes perfectly colorless. The color is not affected when the mineral is raised to a red heat.

The features of benitoite as a gem are its brilliancy, attractive colors, and strong dichroism, and its hardness is nearly equal to that of peridot or kunzite. The depth of color varies in different portions of many of the crystals, while the strong dichroism causes a variation of color depending on the direction the crystal is viewed. Light transmitted perpendicularly to the base is practically colorless, while that parallel to the base, or perpendicular to the principal axis, is blue. To secure the best effect, then, the gem should be cut with the table parallel to the principal axis and not to the base, which is contrary to the rule for sapphire.

Benitoite occurs in veins and pockets or geodes in a lens of basic schist inclosed in one of the largest serpentine areas of the Coast Range of California. The mineral is associated with natrolite and a black or brownish-black mineral, thought to be a new species and called carlosite. The lens of schist inclosing the benitoite veins is about 150 feet wide and at least 1,200 feet long, and cuts through a low serpentine hill with a strike of about N. 70° W. and a dip of 70° to 80° NE. The schist varies in color from dark greenish on the southwest border to bluish in the immediate vicinity of the gem-bearing veins near the middle of the mass. The bluish portion is an altered phase, and is often largely replaced by natrolite in contact with the veins. The altered portions of the schist are full of cracks

[a] Bull. Dept. Geol. Univ California, vol. 5, No. 9, July, 1907, pp. 149–153.
[b] Science, February 21, 1908, pp. 312–314.

and cavities varying in size up to 2 or 3 inches in width and roughly parallel to the planes of schistosity. The cavities are generally filled with natrolite, with or without benitoite or carlosite, or both. Natrolite is not always accompanied by benitoite, though benitoite has not been observed without natrolite. The associations of the minerals indicate that the crystallization of the benitoite and carlosite was previous to the complete deposition of the natrolite.

Development work consists of a tunnel 50 feet long and several open cuts, the largest of which is 10 feet deep, 4 feet wide, and 14 feet long, following the strike of the schist. The gems are removed by pounding up the richer portions of the matrix and picking out the crystals or fragments remaining, or large crystals are chiseled out at the expense of the smaller ones. Since benitoite is rather brittle, a large percentage is lost in this operation.

As reported to the Survey, the production in 1907 amounted to about 15 pounds of rough benitoite, a large part of which was not suitable for cutting. Up to January 1, 1908, 350 carats of gems had been cut from this material.

BERYL.

The production of beryl gems, as aquamarine, blue beryl, golden beryl, rose or pink beryl, and white beryl, was chiefly from California, North Carolina, Colorado, and Maine, with small amounts from New Hampshire, Pennsylvania, and Connecticut.

CALIFORNIA.

The California output came from near Ramona, Mesa Grande, and Pala in San Diego County, and Riverside, Riverside County. Descriptions of some of the localities in San Diego County are given under the notes on the gem minerals of southern California (pp. 43–48). Mr. C. O. Johnson describes[a] the occurrence of new deposits of beryl about 2 miles east of Riverside at the base of the Box Springs Mountains. The beryls are of a good aquamarine color, some approaching the emerald in depth of color. The best material was found on the land of F. D. Mears in a pegmatite formation cutting diorite or gabbro. Dark-green colored mica is also found with the beryl, but not lepidolite, as generally occurs in the gem-bearing pegmatites of southern California. About 20 pounds of rough material, part suitable for cutting, was obtained before development work was stopped through financial troubles.

COLORADO.

Beryl from Colorado was reported as aquamarine, chiefly from the gem mines in Royal Gorge and Mount Antero, Chaffee County, by C. A. Beghtol & Co. Mr. J. D. Endicott reports the discovery of four deposits of aquamarine-colored beryl, some suitable for cutting, associated with rose quartz, about 6 miles north of Texas Creek, Fremont County.

IDAHO.

Mr. Ernest Schernikow, of New York, reports the finding of two good blue beryl crystals near Lewiston, Idaho. These crystals were obtained from an Indian squaw who would not reveal their source.

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[a] Personal letter, dated April 24, 1908.

NORTH CAROLINA.

Regular mining for aquamarine and the beryl gems was carried on in North Carolina during 1907 at Hiddenite. Scattered lots were brought in by mica miners and prospectors in other parts of the mountain country, chiefly in Mitchell and Yancey counties, though some were obtained in Iredell County and at Barretts Mountain, Alexander County.

The hiddenite and emerald mine, one-half mile west of Hiddenite, Alexander County, was reopened and worked during part of the year by Mr. Cary Wright for the American Gem Mining Syndicate. At the same time Mr. Wright opened a new prospect called the Ellis emerald mine, one-fourth mile east of Hiddenite. The work was stopped in September, 1907, pending the installation of a power plant for larger operations. Aquamarine and beautiful specimen beryl, emerald, and hiddenite were obtained in promising quantities. Mr. Wright mentions one beautiful specimen of beryl, 2 inches long by 1½ inches in diameter, weighing over 750 carats, from the emerald-hiddenite mine. It was translucent with prism faces highly polished. Many aquamarine crystals of from 10 to 20 carats were found in the same mine. Several fine crystals of aquamarine were found at the Ellis mine, two of which were embedded in transparent quartz crystals, making splendid cabinet specimens. Emeralds of fine color were obtained from both mines. At the Ellis mine one dark-green emerald weighing 276 carats was found. About 200 carats of hiddenite were obtained from the emerald-hiddenite mine. One crystal, weighing about 10 carats, was one-half colorless and the other half a deep emerald green. Jet black tourmaline crystals associated with feldspar; clear, colorless, smoky, and rutilated quartz crystals; rutile crystals, etc., were also found associated with the beryls.

At the emerald-hiddenite mine there are a large number of veins generally striking north of east with high dips to the north. For a distance of over 50 yards both to the north and to the south of the main workings a number of pits and several shafts have been made on different veins. In all of the veins opened quartz crystals were found, some very clear and beautiful, with well-developed crystal form. Some of these openings yielded beryl or hiddenite, occasionally of gem quality.

The old workings at the emerald-hiddenite mine were made chiefly between 1880 and 1885, and consisted of a large open cut, with two shafts near the western end, besides numerous smaller test pits in the vicinity of the open cut. The open cut is situated near the top of a low ridge and is probably 150 feet long, 20 to 40 feet wide, and 15 to 20 feet deep. A haulway had been cut to the same level at the east end to the dump. The new work in 1907 consisted of an open pit, some 12 feet wide and 18 feet long, near the eastern end of the old cut and at the north side of the haulway. Two well-defined veins were found in this cut, and also two less promising ones. These veins were nearly parallel, and the strike measured on the best one was N. 70° E., dip about 85° N. Several good, though small, pockets were found in this cut.

The country rock in the region around the emerald-hiddenite mine and the Ellis emerald mine is chiefly biotite gneiss, garnetiferous in places, which has been much compressed and folded, probably while

in a plastic condition. Veinlets of quartz in the original rock have been folded and crumpled during this compression into forms resembling folded ribbon. The country rock in the neighborhood of the veins has been highly silicified by the addition of much quartz. This quartz along with other minerals, as muscovite, rutile, pyrite, etc., has replaced the biotite and feldspars and other minerals of the country rock. This replacement was later than the compression of the rock and about contemporaneous with the deposition of the vein matter. These phases are beautifully illustrated in hand specimens which show typical biotite gneiss with folded quartz veins, several feet from a vein, and in similar rock, highly silicified, with a portion of the vein-filling adhering. In the latter specimen the vein filling a fissure is glassy quartz with calcite, rutile, and pyrite inclusions. The wall next to the vein consists largely of granular quartz and an emerald-green (chrome) muscovite, with a little rutile and pyrite. At about 1 inch from the vein the replacement of the country rock is not so complete, and biotite becomes gradually prominent in the rock. At 2 inches from the vein the rock is nearly black biotite gneiss, rich in quartz. A folded quartz veinlet cuts the gneiss to the vein wall. It is more prominent in the black gneiss than in the highly replaced gneiss, though it can readily be traced through the latter, since the quartz of which it is composed was not so easily replaced as certain constituents of the gneiss. Some of the rock cut by the veins contains much chlorite and has a yellowish-green color.

The material filling the gem-bearing veins consists of quartz, calcite, dolomite, muscovite, rutile, black tourmaline, aquamarine and emerald beryl, hiddenite, pyrite, chalcopyrite, and monazite. All of the veins in the neighborhood do not contain all of these minerals, but each of the numerous veins exposed in the workings contain some or all of them. In the cavities all of these minerals occur in crystals; in solid-vein matter certain ones only have crystal form. The calcite was introduced after the other minerals had been deposited, in many places filling up previously existing cavities. Crystals of the other minerals are embedded in solid calcite veins, and calcite has been deposited between broken fragments of beryl and other crystals. Rutile suitable for cutting is plentiful in brilliant crystals, some long and slender, others short and thick. The crystals are commonly twinned, several crystals often joined or crossing each other at angles of 60°, forming beautiful cabinet specimens of rosettes or reticulated masses of needles. The gem minerals—emerald, aqamarine, and hiddenite—occur in distinct crystals in the veins, and when lining the walls of cavities and of good color they make a beautiful contrast with the associated gangue minerals.

The vein at the Ellis emerald mine is pegmatite, with cavities and pockets included in it. The pegmatite strikes N. 50° E., with a high northerly to vertical dip. There are stringers or arms of pegmatite along the walls, and at one place the pegmatite is composed along one side largely of small mica blocks. The country rock is biotite gneiss, small dikes of quartz diorite being included. The latter weathers out in rounded bowlders or "nigger heads," which are scattered over the surface near the mine. The quartz in portions of the pegmatite is a fairly dark rose color. So far, however, none suitable for gem purposes has been found.

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CALIFORNITE.

Californite is a compact variety of vesuvianite with color and texture so like jade that it was at first mistaken for that mineral. It is found in Siskiyou County, Cal., on the south fork of Indian Creek, 12 miles from Happy Camp, and has been described by Dr. George F. Kunz.[a] Two other localities are known where californite has been found in Tulare County, Cal. One of these was described in this report for 1906. During 1907 there was a considerable production of californite by the Himalaya Mining Company from its mine in Siskiyou County.

CAT'S-EYE OR TIGER-EYE.

CALIFORNIA.

New variety.—A specimen was received at the Survey from Mrs. Gertrude S. McMullen, of the Southwest Turquoise Company of Los Angeles, Cal., which seems to be a new species of cat's-eye or tiger-eye. The mineral is a compact variety of serpentine, sufficiently fibrous to have a silky luster, though not readily separated into fibers like asbestos. The hardness is about 4.5. The color is opaque gray with the grain and dark green across it. A cabochon stone cut with the grain gives an excellent play of light across the rounded surface as the stone is rocked. The bar of light reflected from the middle of the stone is greenish gray, while the color on the sides at the ends of the fibers is dark green. The beauty of the gem is somewhat marred in some specimens at least by frequent irregularly shaped bars and tubes of yellowish mineral, apparently also serpentine, running for some distance through the massive material and parallel to its fibers. If the mineral is found without these yellow markings, as it doubtless will be, very attractive stones for scarf pins, pendants, etc., could be cut from it. This mineral is found in Tulare County, associated with asbestos and other serpentine. It might appropriately be called California cat's-eye or tiger-eye, if no other name has been given to it.

CHRYSOPRASE AND BLUE CHRYSOPRASE.

CALIFORNIA.

There was a large production of chrysoprase from the mine of the Himalaya Mining Company, in Tulare County, Cal. Some of this material is of beautiful color and is suitable for high-grade jewelry. It is used also for handsome ornamental effects, as in mosaics, etc.

ARIZONA.

Specimens of blue and bluish-green copper-stained chalcedony were received from Mr. H. P. Wightman, of Globe, Ariz. The mineral occurs in small stringers in the Keystone copper mine in that district. The copper ore at this mine is said to be principally chrysocolla or silicate ore. The chalcedony varies in color from bright to pale blue, bluish green, and nearly apple green, and is more or less translucent. In some pieces the color occurs in curved layers and varies in intensity,

[a] Jewelers' materials and ornamental stones of California: California State Min. Bur. Bull. 37, 1905, pp. 93-95.

thus bringing out the mammillary structure of chalcedony in peculiar wavy markings. In other pieces the color approaches that of chrysoprase, or resembles that seen in certain artificially colored chalcedony. Mr. Wightman reports a sale of probably 200 pounds of selected mineral during 1907 by the miners in Globe. After cutting, this blue chrysoprase brings locally from $3 to $10 a piece for the best grades.

DIAMOND.

UNITED STATES.

Arkansas.—The work of testing the Arkansas diamond deposit continues quietly. A brief report on the locality was prepared by Philip F. Schneider[a] for the Arkansas Bureau of Mines.

The latest authoritative information on the Arkansas diamond deposit has been given by Messrs. Kunz and Washington in a paper before the February meeting, 1908, of the American Institute of Mining Engineers in New York. The general geology of the area and the petrography and weathering of the peridotite are described as they were in a paper by the same authors incorporated in this report for 1906. In tests made with a diamond drill the peridotite was proven to depths of 80, 186, and 205 feet. The green and yellow grounds underlying the layer of black, sticky "gumbo" soil were found to extend down 40 feet in places and are estimated to average 20 feet in depth over the area. The outcrop of the peridotite is estimated to cover about 40 acres, though it may be found larger after further exploration.

General conditions concerning future work are briefly discussed. Water supply, timber, and coal are available, and labor and transportation facilities can probably be satisfactorily arranged. Some 140 diamonds have been found, with an aggregate weight of about 200 carats. The largest stone weighs less than 6½ carats, though the average size compares favorably with the general run of most of the South African diamonds. There is a large proportion of white stones, many of which are free from flaws and are very brilliant. Some of the yellow diamonds are also of exceptional quality and color. The genuineness of the occurrence of the diamonds in their matrix is reiterated, and the occurrence of one stone embedded in the green ground at a depth of 15 feet is cited to strengthen the conclusion. The quantity of green ground that can be readily washed is large. Portions of the peridotite on the borders of the outcrop are in such hard masses as to indicate that it will not readily decompose. The sludge and cores from the diamond drill tests, however, show a badly altered rock at depth at many places, and suggest that much of the peridotite from depth will readily disintegrate on exposure to the weather. Some fresh hard peridotite will be encountered, as in the South African mines, and will probably have to be treated with a certain amount of crushing. Warning is given against the unscrupulous who will probably claim to have located new peridotite areas "on the same lead" or "an extension" of the present one. It is pointed out that since this peridotite has the form of a pipe its outcrop will be limited to one place. Even should new areas of this rock be located, and should their nature be proven by an examination of a petrographer,

[a] Schneider, Philip F., A preliminary report on the Arkansas diamond field: Arkansas Bur. Mines, Manufactures and Agriculture.

it will still be necessary to prove the presence of diamonds and in paying quantities. Peridotite rocks are not uncommon, though few are known to be diamond bearing.

California.—Frequent reports have appeared in the newspapers concerning the prospecting for diamonds near Oroville by Mr. M. J. Cooney. It appears that washing machinery and more land are to be purchased and extensive prospecting is to be carried on. Besides the occurrence of a rock claimed to be identical in appearance with the kimberlite of South Africa, reports state that diamonds have been found associated with that rock. Authentic finds of diamonds in this section of Butte County are recorded,[a] especially at Cherokee above Oroville. These diamonds have come from alluvial deposits, however, and were generally found in washing for gold. Up to the present time no authenticated discovery of diamond in its original matrix in California is recorded. During the early part of 1907, specimens of serpentinized rock called "kimberlite" from the supposed diamond pipe were kindly sent to the Survey by Mr. Cooney. These specimens were discussed in this report for 1906. Upon careful examination and comparison with typical kimberlite from South Africa, it became evident that the Oroville rock was quite different from true kimberlite.

Kentucky.—Newspaper reports have appeared telling of the discovery of diamonds in Kentucky during 1907, though no authenticated finds are recorded.

According to the report of Mr. H. A. Millar, secretary of the Kentucky Diamond Mining and Developing Company, the complete diamond washing plant installed by that company on Creech's Creek in Elliott County was operated during the latter part of the summer and in the early fall. Overburden was removed from three portions of the kimberlite rock outcrop, and some of the yellow ground was washed. Delays were caused by the breaking of the gearing, and operations were finally closed for the winter on the 22d of October, when the water supply for washing was exhausted. Though a total of 2,825 loads of 18 cubic feet were washed without finding diamonds, operations were to be resumed in the spring of 1908.

SOUTH AFRICA.

Griqualand West.—According to the nineteenth annual report of the De Beers Consolidated Mines,[b] the number of loads of "blue" raised and washed and the quantity and value of diamonds obtained again showed large increases. The total production of blue ground at all the mines—De Beers, Kimberly, Wesselton, Bultfontein, and Dutoitspan—was 9,010,686 loads, as against 8,144,979 loads in 1906, and the total quantity washed was 6,626,291 loads, as against 5,625,592 loads in 1906. This leaves a remainder of 9,391,603 loads on the floors, as against 6,769,126 in 1906, an increase of 2,622,477 loads. The number of carats of diamonds won from all the mines and from the tailings and débris was 2,619,872, as against 2,213,991 carats in 1906. The increase in the number of diamonds won came from the Wesselton, Bultfontein, and Dutoitspan mines, and from the increased quantity of tailings washed. The average yield per

[a] Turner, H. W., Diamonds in California: Am. Geol., vol. 23, 1899, pp. 182-191.
[b] Nineteenth Ann. Rept. De Beers Consolidated Mines for year ending June 30, 1907.

load was slightly less in 1907 than in 1906 for all of the mines except the Wesselton, which showed an increase. The average yield of all of the mines in 1907 was 0.3125 carats per load, as against 0.3250 carats in 1906. The average value per carat was greater in the Bultfontein, De Beers, and Kimberly mines, and less in the Wesselton and Dutoitspan. In the Wesselton mine alone was the average value per load greater in 1907 than in 1906. The total quantity of "blue" in sight above the lowest levels of the mines and on the floors was 57,409,013 loads, as against 64,315,580 loads in 1906. The deepest workings were in the Kimberly mine, where the main shaft was down 2,599 feet; the hoisting was done from the 2,520-foot level. At the De Beers mine hoisting was done from the 2,040-foot level, though the deepest shaft was 2,466 feet. Hoisting from the other three mines was all done from a depth of less than 1,000 feet.

The sale of diamonds realized £6,452,597, as against £5,607,718 in 1906. The net profits were £2,607,240. Dividends amounting to £2,550,000, or £750,000 more than in 1906, were distributed, and a balance of £932,624 was brought forward. The buying syndicate took diamonds valued at about £1,000,000 more than the minimum limit contracted. Up to November of 1907, however, only the minimum limit called for by the contract had been bought. Finding that there was to be no relief from the heavy income tax, amounting to nearly £100,000 annually, imposed by the British Government, the De Beers Company voted to transfer from London to South Africa its office controlling operations at the mines. The London tax would have been an especially heavy burden, since the company will probably have a 10 per cent tax on profits to pay to the Cape government also.

Transvaal.—The production of diamonds in Transvaal [a] during the fiscal year 1907 amounted to 1,545,336 carats, valued at £2,203,511, an increase of 786,930 carats and of £1,235,282 over 1906. The production was chiefly from six volcanic pipe mines, the alluvial diggings at Christiana contributing only 2,562 carats, valued at £13,579. The Premier mine was the principal producer, having perfected its mine equipment. Several million loads of ore can be handled a year at this mine, and a regular and adequate water supply and a satisfactory method of disposing of tailings and slums have been provided.

Orange River Colony.[b]—The production of diamonds in the Orange River Colony during the fiscal year ending June 30, 1907, is given by Mr. Burnet Adams as 398,703 carats, valued at £1,221,202, as compared with a value of £902,727 in 1906. The increase comes chiefly from the two new mines—the Roberts-Victor and the Voorspoed. Other mines producing were the Jagersfontein, Koffyfontein, Lace, Monastery, and the alluvial diggings. The yield of the alluvial diggings was 7,103 carats, valued at £36,895, while the matrix mines produced 391,600 carats, valued at £1,185,308. The price per carat of the alluvial diamonds is about 43 per cent higher than of those from the pipe mines. The production for the calendar year 1907 is given for the Roberts-Victor mine [c] as 123,427 carats, an average of 0.536 carat per load, and for the Voorspoed as 40,653 carats, an average of 0.21 carats per load.

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[a] Ann. Rept. Govt. Min. Eng., Transvaal, 1907.
[b] Mines Dept. Orange River Colony, Fourth Ann. Rept., 1907, Bloemfontein.
[c] Mining Jour., London, February 1, 1908

Vaal River diamonds.—The terraces and river gravels along the Vaal River from Bloemhof, in Transvaal, to its junction with the Orange River in Griqualand West, a distance of about 200 miles, have been worked for diamonds.[a] The deposits vary from a few inches to 40 or 50 feet in thickness, and in some cases extend 3 or 4 miles laterally from the river. The gravels consist of a large number of greenstone bowlders filled in with sand and pebbles, and resting on a flow of amygdaloidal greenstone. The pebbles are chiefly siliceous, as jasper, chalcedony, agate, etc., and with them are associated pebbles of greenstone, ironstone, ilmenite, garnet, topaz, and diamond. There has been more than one period of sedimentation, and the gravels of the most recent period have a matrix of stiff siliceous clay. The diamonds have been found almost everywhere through the gravel deposits, there being no reliable geological indications as to their occurrence. The placer diamonds, taken collectively, are probably the finest stones obtainable in South Africa. They occur more commonly in dodecahedral crystals and are singularly free from flaws. Stones with a yellowish tint are predominant, though all colors are found. The value is estimated at about £6 per carat for all diamonds sold to buyers along the river.

SOUTH AMERICA.

Brazil.—The diamond and carbon mining industry of Brazil is increasing. Consul-General George E. Anderson, of Rio de Janeiro, reports that dredges[b] have been installed along the Jequitinhonha River, in the State of Minas Geraes, and that large amounts of American capital are being invested in the Diamantina country. The work on the mines in the latter region has necessitated the building of a highway from the end of the railroad at Curalinho. This work is under the direction of an American engineer and will be carried out by American methods. Heretofore the shipments of Brazilian diamonds have been to Europe, though it is likely a number of them will be made to this country direct, now that American capital is so heavily interested.

It is difficult to obtain information on the production of Brazilian diamonds, since large quantities were smuggled out of the country to avoid the payment of the 5 per cent export tax. Consul-General Anderson, in the report quoted above, gives the value of diamonds registered for export during 1906 as $310,000. This is said to include the carbons or black diamonds from Bahia. That the official export figures do not adequately represent value of the production is shown by the figures given in a report by former Vice-Consul J. P. W. Rowe,[c] of Bahia, in which it is estimated the annual exports from that State amount to over $4,000,000. The State government of Bahia found that it failed to receive the proper revenue due from the 7 per cent export tax, and accordingly abolished the export-tax law in favor of another. Each merchant or dealer shipping diamonds or carbons was to be charged an amount calculated to bring the revenue up to what it should have been under the 7 per cent export-tax law. The new law was met by the combining of many dealers and their shipping as one firm.

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[a] Park, Mungo, Vaal River, South Africa, diamond fields: Mining Science, March 19, 1908.
[b] U. S. Daily Cons. Repts., January 20, 1908.
[c] U. S. Daily Cons. Repts., January 7, 1908.

British Guiana.—The output of diamonds in British Guiana is chiefly in small sizes. The government report for the year ending June 30, 1907, shows a production[a] of 65,903 stones, weighing 4,718 carats. The change from the preceding year was not large, though in 1904–5 the output was 175,400 diamonds, weighing 10,619 carats. An idea of the value of British Guiana diamonds may be gained from the exports between January 1 and September 18, 1907,[b] which are placed at 1,564 carats, valued at $12,370.

INDIA.

The production of diamonds in India[c] is given for 1906 as 305.9 carats, valued at £5,160, as against 172.4 carats (valued at £2,474) in 1905. The increased production came chiefly from Panna, where the value of output was £4,348. The remainder of the production came from the states of Charkhari and Ajaigarh.

NEW SOUTH WALES.[d]

The total production of diamonds in New South Wales between the years 1867 and 1906 is given as 157,137 carats, valued at £104,089. The largest productions recorded were in the years 1899 and 1904, being 25,874 carats valued at £10,350, and 14,296 carats valued at £11,620, respectively. The production for 1906 was considerably smaller and amounted to 2,827 carats valued at £2,120.

DIAMOND INDUSTRY.

The consumption of diamonds in the United States is ordinarily large and amounts to over one-half of the world's production. With the immense falling off in purchases of diamonds in the United States caused by the financial depression in 1907 and reduced sales in other countries, the diamond industry has had to face a serious situation. The decreased demand for diamonds has affected all branches of the industry. Large numbers of cutters, not only in the United States but also abroad, have been without employment for several months. Several diamond mining companies have been forced to close their mines or limit their output. At one time it was rumored that the price of diamonds would fall when the agreement of the De Beers and Premier diamond mining companies with the diamond buying syndicate expired in the latter part of March, 1908. The reduction of price by one large company would have precipitated a war of low prices with the other, and this would have ruined those dealers with large stocks of high-priced diamonds on hand. The six months' agreement made in 1907, by which the diamond buying syndicate was to purchase the output of the Premier mine at a certain value proportional to that paid for the De Beers output, was not renewed after expiration in March, 1908. Frequent assurances, however, have been given to diamond dealers and merchants by both the De Beers and Premier mining companies and the diamond buying syndicate, that the price of diamonds will be maintained under all circumstances.

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[a] Mining World, April 18, 1908.
[b] Mining Jour., London, October 12, 1907.
[c] Rec. Geol Survey India, vol. 36, pt. 2, 1907.
[d] Ann. Rept. Dept. Mines, New South Wales, 1906, p. 53.

Cullinan diamond.—The great Cullinan diamond was presented to King Edward of England on his birthday, by the people of Transvaal as a demonstration of loyalty and high regard. This diamond is now being cut to be placed among the crown jewels of England. In the rough the Cullinan diamond weighed nearly 3,025 carats, or about 1.37 pounds avoirdupois, and was found in the Premier mine, Transvaal, in January, 1905. The cutting and polishing of this huge diamond is being carried on by the firm of Joseph Asscher & Co., in Amsterdam, and will probably not be completed before the end of 1908. According to Mr. Louis Asscher,[a] of the Asscher firm, the cleaving of the diamond was very successfully accomplished by Joseph Asscher, who split it through a defective spot, part of which was left in each portion of the diamond. The diamond was cleft by making an incision half an inch deep with a sharp diamond point in the proper place and then striking a specially designed knife blade placed in the incision a heavy blow with a piece of steel. Apparatus specially designed for polishing the diamond has been constructed as a dop 6 inches across and weighing about 20 pounds, which is raised mechanically from the polishing disk. The latter is about 16½ inches across and makes 2,400 revolutions per minute. Diamond dust mixed with oil will be used in large quantities in polishing the stone. The larger portion will probably be cut into a drop-shaped stone weighing between 500 and 600 carats when completed. The other portion will be cut into smaller stones, one of which, even then, will be one of the large diamonds of the world. Extreme precaution is taken to guard the diamond at all times, both by the use of numerous watchmen and by combinations of safes.

Hope blue diamond.—The famous "Hope" blue diamond has been sold by Joseph Frankel's Sons of New York. The buyer is Señor S. I. Habid,[b] a Spanish collector in Paris, and the price was about $400,000. The "Hope" diamond is a beautiful blue, very brilliant stone weighing 44½ carats, believed to be a part of the wonderful blue diamond, weighing 112 carats, brought from India by Tavernier in 1642 and sold to Louis XIV. A century later this diamond was cut into a triangular shaped stone weighing about 67 carats. In 1792 it was stolen, and no trace was ever discovered. In 1830 three blue diamonds, of the same color and quality as the Tavernier stone appeared on the market. The aggregate weight of these three diamonds was less than that of the stolen French jewel by an amount which would naturally be lost in cutting. The largest stone was purchased by Henry Thomas Hope, from whom it was named. After Mr. Hope's death the diamond was purchased from the heirs by Joseph Frankel.

Metric carat.—The weight of the carat used in different parts of the world is quite variable, ranging from 188.5 milligrams in Boulogne to 213.3 in Turin and to 254.6 in Arabia.[c] The weights most used, however, fall between 205 and 207 milligrams. The advantages to be gained by the use of a standard carat for all countries bearing a simple relation to other standard weights can readily be seen. The metric carat, of 200 milligrams, answers this purpose well and is not greatly

[a] Jewelers' Circ. Weekly, May 20, 1908.
[b] Manuf. Jeweler, May 21, 1908.
[c] Valentine, E. J., The carat weight: Mining Science, April 30, 1908.

different from the carat used by several countries. With the acceptance by the international committee of weights and measures and the sexennial conference of the metric convention,[a] the metric carat is a legal weight in all countries using the metric system of weights and measures.

Artificial diamonds.—Much interest has been manifested in the case of Sir Julius Wernher, of the De Beers Company, against a French engineer, Henri Lemoine, who claimed to manufacture diamonds by a secret process. In 1904 Lemoine succeeded in interesting Sir Julius in his process, and when its genuineness was apparently established a contract was drawn up. Under the conditions of this contract Lemoine was to receive a large sum of money for his invention, which was to remain secret until his death, and all diamonds made were to be turned over to Sir Julius. A description of the process of manufacture was placed in a sealed envelope and deposited in the Union of London and Smith's Bank, where it was to remain until Lemoine's death and then to become the property of Sir Julius. It is said that over $300,000 were advanced to Lemoine for a factory and apparatus, and for this sum, or part of it, Sir Julius brought suit, since he no longer had faith in Lemoine's process. During the trial Lemoine asked for an opportunity to give a demonstration, and during April, 1908, was released on bail for this purpose. After making elaborate preparations he not only failed to produce artificial diamonds but forfeited his bail and fled. The sealed envelope was opened and was found to contain a jumble of recipes of no value.

EMERALD.

NORTH CAROLINA.

Emerald was obtained from three places in North Carolina during 1907. The greater part came from the emerald-hiddenite mine and the Ellis emerald mine, already described under beryl. Of the remainder, part was found at a prospect belonging to Mr. W. H. Warren, 1 mile north of Hiddenite, and part consisted of emerald matrix from Mitchell County probably mined some years ago and recently cut.

COLOMBIA.

A few notes on the famous emerald mines of Muzo, Colombia, are given in a letter from Bogota, based on the report of the German minister to his government, in the New York Herald.[b] The mines are now leased to a Colombian syndicate for a period of five years, under rigid government supervision. The Government expects to work the mines on its own account when the present lease expires. The mines are on the side of a steep mountain about 350 feet above the mining village. Formerly the Spaniards worked them for emeralds by driving adits into the hillsides; now they are operated by open cut work with terraces. The rock is broken into smaller and smaller fragments by peons, who pick the gems out from washing troughs.

[a] Comptes rendus des séances de la quatrième conférence générale des poids et mesures, Paris 1907, p. 60.
[b] Jewelers' Circ. Weekly, November 13, 1907.

A plentiful supply of water is obtained from the mountains for washing purposes, and the débris is washed down to the Rio Minero. Over 100 persons are employed at wages of about 25 cents a day with food, shelter, and medical attendance free. The workmen are protected from the sun by canvas awnings and palm leaf shelters. Even then the temperature in the pit reaches 115° to 120°, and the air is excessively humid. The peons are carefully watched, and every stone is turned over to inspectors as soon as it is found. The latter clean the gems and report to the government officials. At least $1,000,000 worth of emeralds were mined and sold during 1906.

GARNET.

Several varieties of gem garnets were produced during 1907, and from several States. The most important were the hyacinth garnets, spessartite, and essonite, which were obtained chiefly from California, though Mr. Don Maguire, of Ogden, reported a large production of rough spessartite from San Juan County, Utah. Much of the hyacinth came from the foothills in the desert near Dos Cabezas Springs, San Diego County, Cal., where the San Diego Gem Company owns ten claims. The remainder came from the gem mines near Ramona and Mesa Grande, Cal.

Mr. W. P. Dorsey sent in specimens of hyacinth garnets found by him near Silver City, N. Mex. They were small, clear, trapezohedral crystals with a rich yellowish-red to brown color. The crystals varied from pin-head size to 3 or 4 millimeters in diameter, and will furnish beautiful gems if larger ones are found. The garnet crystals were associated with quartz crystals in the specimens, both appearing to line cavities in a feldspathic rock impregnated with garnet and quartz.

A quantity of pyrope garnets were collected from the Indian reservations in northeastern Arizona and northwestern New Mexico. Mr. J. L. Hubbell, of Ganado, Ariz., mentions a locality about 75 miles west of north of Ganado where garnet is found abundantly over a stretch of country about 10 miles long. The garnets are picked up from the surface of the ground by the Indians. They occur in a sandy soil and are uncovered by the action of the wind.

Mr. Samuel Scott, of Custer, S. Dak., reports the occurrence of beautiful red garnets 4 miles west of Custer in Elephant Gulch. These garnets were obtained while mining for placer gold, and the flawless ones were sold as gems at from 10 cents to $5 each.

The majority of the garnets are found in well-developed dodecahedral crystals with smooth faces. Small garnets, the size of a grain of wheat, are abundant, but stones suitable for cutting into large gems are rare. Some of the smaller garnets are saved by the miners and sold in small vials to tourists.

Mr. J. D. Endicott reports the discovery of a band of mica schist carrying almandine garnets, near Canon City. Some of these garnets are as much as 1½ to 3½ inches in diameter. They have a rich red color, and some have portions that are clear and free from flaws. About 10 pounds of stones fit for cutting into small gems were obtained at this locality during 1907.

GOLD QUARTZ.

A new variety of gold quartz from the Quartet mine, Searchlight, Nev., has been cut into small articles, such as watch charms, etc., by Mr. William Petry, of Los Angeles, Cal. A small specimen, kindly sent to the Survey by Mr. Petry, contained much bright yellow free gold in irregularly shaped particles and flakes in and between the grains of granular quartz. Most of the quartz appears bright green from the presence of films and small masses of malachite between the grains. The specimen also contained patches of purplish stains which could not be identified. The combination of colors makes an attractive small ornament, though the presence of malachite with quartz may give trouble in producing a high polish.

JADE.

BURMA.

The production of jade (jadeite) in the Myitkyina district of Upper Burma during 1906 amounted to 2,214½ hundred weight.[a] This was less than in 1905, owing to scarcity of labor. The exports of jade, through Rangoon, however, were greater and amounted to 2,566 hundredweight, valued at £64,433, in 1906, as against 2,342 hundredweight, valued at £43,474, in 1905. In 1905 there was a further export of 343 hundredweight, valued at £2,000, overland to China.

JASPER.

There was a production of jasper in Colorado and southern California during 1907. Mrs. Gertrude S. McMullen, of the Southwest Turquoise Company, of Los Angeles, mentions a vein of jasper in San Bernardino County, Cal, from which a specimen was sent to the Survey. This deposit is owned by the Cracker Jack Bonanza Gold Mining Company. The jasper has a dark-red brown or liver color, and is mottled with many small gray streaks. The mottled effect is due to a former brecciation of the jasper, with a subsequent cementation by chalcedony. Some of this jasper has been polished by the Southwest Turquoise Company, and furnishes handsome small ornamental objects, though the color is rather dark and of course the mineral is expensive to polish since it is so hard.

Good jasper is known to occur in the eastern part of San Diego County, Cal., and from this region jasper was obtained during 1907. The Native Gem Mining Company reports that abundant material can be obtained from its mine. Mr. John F. Schwartz, of San Diego, describes some of the jasper from Dulzura, San Diego County, as very handsome; but he makes the same statement as do others who have handled the California jasper, that it is so hard to cut as to render it doubtful whether the deposits will be worked commercially.

Mr. Louis J. Deacon describes the occurrence of smooth, waterworn pebbles of brick-red, brown, and yellow jasper, associated with quartz pebbles and occasional jet black flinty quartz, on the Delaware Bay beach at Cape May, N. J. The occurrence is similar to that of the "pebble beach" of Redondo, Cal. Both at Redondo and at

[a] Rec. Geol. Survey India, vol. 36, pt. 2, 1907.

Cape May visitors spend much time searching for pebbles suitable for cutting or for specimens. Mr. A. C. Keck describes the occurrence of very fine red and green jasper pebbles with chalcedony and other gems at Redondo. The chalcedony is cut and sold as moonstone, and the jasper as bloodstone and sardonyx.

OPAL.

UNITED STATES.

A small quantity of opal was reported from Oregon, California, Colorado, and North Carolina. That from Oregon was probably from the deposit in the eastern part of the State, a few miles below the town of Durkee, described by Dr. Kunz[a] as occurring in cavities in rhyolite tuff. The opal from California came from the deposits in San Bernardino County, about 20 miles northwest of Barstow. Small pieces of precious opal and handsome specimen and ornamental material have been found here. Some of the latter variety obtained by Mr. C. O. Johnson is described[b] as dark red jasper streaked with semi-opal. Mr. J. D. Endicott reports the discovery of lechosos or milky opal in the water-worn gravels in the foot-hills south of Canon City, Colo. Opal in North Carolina was limited to one specimen of lechosos or milky opal found in the southern part of Iredell County by Mr. J. T. Cashion.

NEW SOUTH WALES.

The production of opal in New South Wales is still largely from the White Cliffs division.[c] New grounds have been opened in the neighborhood of White Cliffs and near Bunker, or Gemville. The ranges along the White Cliffs are still unprospected, though it is thought they contain rich deposits of opal. There was an increase in production from Wallangulla and Lightning Ridge, in Walgett division. The production of opal from 1890 to 1906 is given as £989,099. The largest productions were £135,000 in 1899 and £140,000 in 1902. The production for 1906 amounted to £56,000, of which about £50,000 came from White Cliffs.

HUNGARY.

The opal mines of upper Hungary were advertised in 1907 for lease for a period of ten years[d] or longer, or to be sold by the Government. At the same time about 30,000 carats of polished precious opal deposited with the exchequer was to be put up for sale.

PERIDOT.

Peridot was produced in 1907 in the northeastern part of Arizona and the northwestern part of New Mexico. The output came, as usual, chiefly from the Indian reservations, where the stones were gathered by the Indians and traded at different points. Mr. J. L. Hubbell reports a quantity of peridot gathered from the surface on the Ziltsusayan Butte, about 20 miles northeast of Ganado, Ariz.

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[a] Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, p. 1247.
[b] San Diego News, January 23, 1908.
[c] Ann. Rept. Dept. of Mines, New South Wales, 1906, p. 53.
[d] Mining World, May 18, 1907.

PETRIFIED WOOD.

Petrified wood occurs at a number of localities in the Western States. Mr. W. C. Hart reports the sale of some 5,000 pounds during 1907, obtained from El Paso County, Colo. Mr. Samuel Scott reports that agatized and jasperized wood is plentiful in the Dakota sandstone formation around the Black Hills. This material is not used at the present time. The beautiful petrified wood from the petrified forests of Arizona, near Adamana, is carried off in some quantity each year as specimens and souvenirs by tourists. The specimens taken are generally limited to a few pounds in weight, and some of them are later polished for ornamental purposes.

PHENACITE.

A small quantity of phenacite was reported from Bald Face Mountain, Stoneham, Maine, by Messrs. Bickford Brothers, of Norway, Maine, and by Mr. Leon Allen. Part of this was gem material and part specimen material consisting of crystals attached to quartz crystals.

QUARTZ.

The quartz produced, including rock crystal, smoky, citrine, rutilated, and tourmalinated quartz, came from California, Colorado, North Carolina, Maine, Pennsylvania, and Connecticut. In the first four States mentioned the quartz came from mines or regions around mines noted for their beautiful gems, as tourmaline, beryl, emerald, kunzite, and hiddenite. A small quantity of rutilated quartz was obtained from the mines near Hiddenite, Alexander County, N. C., and in the adjoining county of Iredell. Of much interest is the polishing of a large crystal sphere by the Catalina Novelty Company, of Avalon, Cal. This sphere is reported to be six inches in diameter and quite perfect.[a] According to a press report,[b] it is 19 inches in circumference and weighs 11 pounds. The crystal from which it was cut was found in Riverside County, Cal. The value of the sphere is placed at $3,300.

Mr. Louis J. Deacon mentions the occurrence of clear, pellucid quartz pebbles, called "Cape May diamonds," on the Delaware Bay beach at Cape May, N. J. These pebbles are gathered by visitors, who have them cut as souvenirs.

Consul-General G. E. Anderson, of Rio de Janeiro, states that the foreign demand for large-size quartz crystals for optical work is quite variable.[c] The value of the exports of such crystals from Brazil amounted to $16,103 in 1904, $18,132 in 1905, and $10,553 in 1906. The fluctuations are due in part to variations in supply. The best crystals come from a belt extending from the central portion of São Paulo through Goyay and the western portion of the State of Minas. The price given as the average for the exports during 1906 was 42 cents per kilogram.

ROSE QUARTZ.

There was a large production of rose quartz, amounting to 51,300 pounds, from South Dakota and Colorado. The largest production was from South Dakota, from the Red Rose vein, 7 miles southeast of Custer. The whole output was not sold during 1907, however.

[a] Personal letter. [b] Jewelers' Circ. Weekly, December 25, 1907. [c] Daily Cons. Repts., August 22, 1907.

Mr. Samuel Scott reports rose quartz in a number of localities in Custer and Pennington counties, S. Dak., though the deposits are not worked. Mr. J. D. Endicott reports the discovery of a ledge of unusually dark-colored transparent rose quartz 6 miles north of Texas Creek, Fremont County, Colo. The ledge is said to outcrop prominently on a mountain side for a length of 125 feet through a height of 30 feet. It occurs in the midst of pegmatite. This deposit is being operated by C. A. Beghtol & Co., and it is expected will yield much fine material. Mr. Frank H. Jackson, of Los Angeles, reports the occurrence of a vein of fine rose quartz in Hemet Valley, 20 miles southeast of Hemet, Riverside County, Cal. The vein is said to be from 6 inches to 3 feet thick, and the material could be obtained by the ton. Rose quartz occurs in numerous pegmatite bodies associated with the gem minerals of southern California.

RUBY.

NORTH CAROLINA.

Interest in the ruby deposits along Caler Fork of Cowee Valley, Macon County, N. C., has been revived through operations of the United States Ruby Mining Company. This company has undertaken to develop the ruby in the matrix lead previously located at "In Situ Hill" in the valley, and expects to wash the ruby-bearing gravels left unworked during former mining operations. For a distance of over 2 miles rubies have been found in the creek gravels, much of which has been worked. The gem-bearing gravels lie both above and below the company's headquarters at the mouth of Dalton Branch. Good rubies have been found in the creek gravels about a mile above the mouth of Dalton Branch as far as "In Situ Hill." This hill is merely the end of a ridge or spur which extends from the mountains on the south side of the valley down close to the creek.

In the report of Mr. C. Barrington Brown, in 1896, to the American Prospecting and Mining Company on the ruby mine of Cowee Valley, the rubies are described as generally of good color, many resembling the true pigeon-blood ruby of Burma. Some of them have bluish borders, which give them a magenta tint. Pratt and Lewis[a] state that some large gems—3 or 4 carats in weight—of good color and transparency and free from inclusions, have been found. Though found in less quantity, the color and quality of these stones equal the Burma rubies. Some of the Cowee Valley rubies contain inclusions of rutile, ilmenite, garnet, etc., or are silky or badly flawed. Much pink and red corundum, some of it approaching the ruby in color and quality, is associated with the ruby. The concentrates obtained in washing for ruby contain red, pink, bluish, gray, and yellowish corundum, ilmenite, rutile, cyanite, red and pink or rhodolite garnet, small zircon crystals, quartz, feldspar, etc. In the New York office of the United States Ruby Mining Company an admirable display of ruby and ruby corundum, as well as specimens of ruby matrix material, has been arranged by Mr. Alfred H. Smith.

During 1907, Mr. N. E. Isbell, of the United States Ruby Mining Company, constructed a new ditch to carry the creek from above "In Situ Hill" along the opposite hillside, where it could be tapped for

[a] Pratt, J. H., and Lewis, V. L., Corundum and the peridotites of western North Carolina: Geol. Survey North Carolina, vol. 1, 1905, pp. 180–186.

pressure for hydraulic purposes. This ditch was extended to a point opposite the mouth of Dalton Branch, where a fall of nearly 100 feet could be obtained to hydraulic the bottom lands below. Another reason for the construction of the ditch was the hope that by turning the creek from its bed close to "In Situ Hill" the flow of water in the shaft on the ruby matrix would be diminished and the surrounding mud become harder. A 20-horsepower engine with a rotary centrifugal pump and bucket elevator were installed to assist in sinking the shaft and driving a crosscut from the bottom through the soft ground.

The matrix in which the ruby corundum occurs, and in which genuine rubies are said to have been found, consists of hornblende gneiss and pegmatite in hornblende gneiss. The pegmatite occurs in small streaks and lens-shaped pockets from an inch or two to a foot thick, roughly conformable with the bedding of the inclosing hornblende gneiss. Both the pegmatite and the hornblende gneiss are very badly decomposed at the surface. The feldspar of the pegmatite has largely passed into kaolin, while the hornblende gneiss has altered to the yellowish brown earth characteristic of the saprolite of that rock, with hydromica and black spots where small garnets have rotted away throughout. That this weathering extends to a depth of over 30 feet is shown by the material removed from a shaft of that depth. The strike of the country rock at "In Situ Hill" is north of east, with a high dip to the southeast. A dike of hard unaltered hornblende eclogite outcrops in the bottom of the valley, a few feet north of the ruby matrix, and can be traced to the east and west some distance. The hornblende gneiss saprolite contains parallel streaks of mica-gneiss saprolite included in it.

In some of the pockets of decomposed pegmatite translucent pink to lilac colored corundum is very abundant, both in fairly large well-formed crystals and in small fragments. Red and ruby colored corundum is less plentiful, and but few crystals of gem quality have been found in the pegmatite bodies so far. Portions of the hornblende saprolite inclosing the pegmatite carry small translucent corundum crystals and fragments, some of rich red color in small pockets of soft white material. These were probably small masses of pegmatite which have decomposed, though they might possibly represent the decomposition products of former corundum crystals. From the few specimens of matrix seen by the writer, it appeared that the corundum associated with larger bodies of pegmatite is inclined to be of a lighter color—pink or lilac—than the richer red stones in the hornblende rock alone, or where pegmatite is less prominent.

INDIA.

Burma.—The production of ruby, sapphire, and spinel by the Burma Ruby Mines Company during the year ended with February 28, 1907,[a] amounted to 326,855 carats, valued at £95,540, as compared with £88,340 in 1906. Of the total value of the output, ruby amounted to £93,023, sapphire to £1,132, and spinel to £1,385. The net profits of the company amounted to £15,160 after deducting a tax of £6,819 paid to the government of India.[b] During the year, 1,890,944 trucks of ruby earth were washed, at a cost of 7.7 pence per truck, as compared with 1,773,129 trucks at 8.1 pence in 1906.

[a] Rec. Geol. Survey India, vol. 36, pt. 2, 1907. [b] Jewelers' Circ. Weekly, September 25, 1907.

SAPPHIRE.

MONTANA.

There was much activity in sapphire mining in Montana during 1907, with a consequent large production, both of the yogo-blue sapphires and of the varicolored sapphires found in other parts of the State. Two large companies operated mines containing blue sapphire in its original matrix, and two other large companies and smaller or individual producers worked auriferous placer deposits containing varicolored sapphires. The blue sapphire in matrix was worked in the Judith River region, in Fergus County, at points about 11 and 13 miles west-southwest of Utica, by the New Mine Sapphire Syndicate and the American Sapphire Company. Placer deposits of varicolored sapphires were operated on the head of Dry Cottonwood Creek, Deerlodge County, by the Variegated Sapphire Company, and along the West Fork of Rock Creek, in Granite County, by the American Gem Mining Syndicate. A little mining was done and a few finds reported from the auriferous sapphire deposits along the Missouri River, below Helena, once so extensively worked.

Yogo blue sapphires.—The blue sapphires of Fergus County, often called "Yogo sapphires," occur in a dike of basic igneous rock [a] cutting nearly perpendicularly across the bedded limestone country rock. The dike crosses the canyon of Yogo Creek (the north fork of Judith River) and the rolling country sloping eastward from the crest of Yogo Canyon to the bottom lands of Judith River, a distance of nearly 4 miles. The limestone country rock belongs to the Madison limestone formation of Carboniferous age, as mapped by W. H. Weed.[b] This formation is over 1,000 feet thick, and consists of thinly bedded strata of light-grayish limestone which dip rather gently to the east. There are a few minor folds in the limestone, some of which can be seen in the walls of Yogo Canyon near the mine of the American Sapphire Company. The sapphire-bearing dike is slightly sinuous and has a strike a little north of east with a nearly vertical dip. In the canyon, however, it seems to split up into two or more parts (one of which pinches out in the limestone) or to be intersected by another dike. The thickness of the main dike throughout its known length varies from 2 to over 14 feet.

The rock of the sapphire-bearing dike has been described by Prof. L. V. Pirsson. When fresh and unaltered it has a dark-gray color with a greenish or bluish cast. The principal constituents are biotite mica and pyroxene, of the diopside variety, with minute and large inclusions of calcite, quartz, pyroxene, and pyrite. Some of the biotite occurs in phenocrysts of 2 or 3 mm. diameter, though the greater part is in small shining flakes, thickly scattered through the rock. The glistening scales of biotite and some of the inclusions are the principal constituents that can be recognized in hand specimens. The inclusions of calcite and quartz are surrounded by reaction rims of pale and sometimes bright emerald green pyroxene. This pyroxene sometimes occurs scattered through the smaller inclusions, or even constitutes the mass of them. The dike rock contains numerous seams and veinlets of calcite and quartz as well as large inclusions

[a] Somewhat fully described by Weed and Pirsson: Twentieth Ann. Rept. U. S. Geol. Survey, pt. 3 1898–99, pp. 454–459 and 552–557.
[b] Geologic Atlas U. S., folio 56 [Little Belt Mountains], U. S. Geol. Survey, 1899.

of limestone. Pyrite in crystals and agglomerations of crystals is scattered through the rock. This pyrite, along with some pseudomorphous limonite, is separated from the rock along with the sapphires and constitutes the greater part of the concentrates obtained in washing for the latter. In thin section under the microscope the biotite is strongly pleochroic, varying from almost colorless to a strong clear brown color. It occurs abundantly in ragged shreds through the rock, rarely with crystal form, and contains small apatite crystals. The pyroxene is pale greenish to colorless and belongs to the variety diopside. It contains numerous inclusions which may originally have been glass. No feldspars have been observed in the rock, though a kaolin-like substance in the interstices may represent a decomposed mineral, as leucite or analcite, especially since the rock resembles a known basic analcite basalt.

The sapphires are scattered through the lamprophyre, none having been observed associated with the limestone inclusions. One sapphire crystal was seen embedded in a mass of heavily pyritized lamprophyre. It is thought the sapphires formed by the crystallization of an excess of alumina dissolved in the lamprophyre magma. The source of this alumina is supposed to be in the shales of the several thousand feet of older formations, underlying the thousand feet of Madison limestone through which the dike cuts. During the intrusion through the shales fragments were torn off and floated up with the magma, by which they were eventually dissolved. When the magma began to solidify the excess of alumina separated out in the form of sapphire. The sapphires crystallized out before the magma completely solidified, for some of them were badly etched and corroded by a partial reabsorption by the magma after formation. Included fragments of limestone taken in at higher levels were acted on to varying degrees by the magma. Smaller masses were metamorphosed to crystallized calcite, and nearly all were surrounded by diopside rims formed by the reaction on the magma.

The sapphires range in size from minute crystals up to 4 or 5 carats. Rarely crystals of 8 or 10 carats are found, the majority, however, weighing under 3 carats. A large quantity of small sapphire, classed as "culls," is obtained. This material is in great demand for watch jewels, for which, through the flattened form of many of the crystals, it is especially suitable. The color of the Yogo sapphire ranges from a light blue to the rich characteristic "cornflower" blue of the oriental sapphire. They make a beautiful gem and are highly prized for their color and brilliancy. Probably over 90 per cent of the sapphire is of good blue color and gem quality, the remainder being grayish or of poor color. Occasional purplish-colored gems are found. The Yogo sapphires occur in rough crystals whose common forms are the base and a rare rhombohedral face $x(3032)$.[a] The basal planes are roughly striated parallel to their intersection with the rhombohedron faces. A repeated development of the base and rhombohedron is not uncommon. The basal planes are badly etched on some crystals, the etched figures generally showing a rhombohedral symmetry and several being sometimes grown together.

New Mine Sapphire Syndicate.—The writer wishes to acknowledge the courtesy shown and the assistance rendered him by Mr. C. T.

[a] Pratt, J H., Crystallography of the Montana sapphires: Am. Jour. Sci., 4th ser., vol. 4, 1897, pp. 24-28.

Gadsden, superintendent, at the time of his visit to the mine of the New Mine Sapphire Syndicate. The earlier mining operations of the New Mine Sapphire Syndicate consisted chiefly of open cuts, of which probably nearly a mile were made along the outcrop of the sapphire-bearing dike. These cuts were from 10 to 60 feet deep, in one place the dike material being removed to a depth of 90 feet. The walls of the cuts were held apart by stulls as needed. At present the sapphire ore is all obtained from underground workings. The latter consist of a shaft 100 feet deep with drifts in each direction from the bottom. The shaft is located in a smaller coulee or valley crossing the dike. The west drift is about 2,000 feet long and nearly 200 feet below the surface of the hill on the west of the coulee, while the levels above and one of the stopes reach nearly to the bottom of the 90-foot open cut in this hill. The east drift was carried nearly 800 feet, with stopes above at varying intervals. At one place in this drift the dike has been stoped out to the surface. The nature of the dike as exposed in these workings is variable in both richness and size. Nearly barren places occur in the dike where the latter seems to be choked with limestone, between the fragments of which there is but little dike material. The barren places commonly occur where the dike pinches down to smaller dimensions, which changes in size were doubtless caused by the jamming of limestone fragments included in the magma in the narrower parts of the fissure at the time of intrusion. In places the walls of the dike are rough where the edges of the limestone strata were broken during the fissuring and fragments were torn off by the intrusion of the dike. Jagged furrows or elbows in the limestone walls show where such fragments were torn off. In some places a single flat bedding plane of the limestone or steps, including several beds, form the bottom of these furrows, which are somewhat wedge-shaped toward the top.

Contrary to reports circulated during 1906 that the work of this company was hindered by the difficulty of disposing of the waste and slums from the sapphire washing, a larger supply of ore was mined and treated during 1907 than ever before. Instead of containing chemicals injurious to vegetation, as claimed by some of the ranchers along the river below the mine, the slums have been shown actually to improve, for raising crops, the lands on which they are turned. Analysis of the slum is also reported to show the presence of nitrates and phosphates, which are helpful to any crop growth. To test this, Mr. C. T. Gadsden, superintendent of the mine, turned the water carrying the slums over portions of the ranch land owned by the company. Oats, alfalfa, and vegetables were successfully grown, both where the slums were turned over crops already planted and where the vegetables were planted directly in thick deposits of slum. In each case vegetation was most luxuriant where the slum was thickest. The coarser sands from the sapphire washings were removed by a sand trap from the sluice ditches, where the grade was low, to keep the latter from clogging up. This was accomplished automatically by a simple device operated by an undershot water-wheel in the sluice.

In some respects the method of separating the sapphires from their matrix is similar to that of separating diamonds from the "blue earth" of South Africa. Near the surface and to a depth of 20 feet and more, the dike rock was decomposed by weathering to a yellowish

clay, from which the sapphires were readily washed. As the work was carried deeper, the dike rock was less altered and hard, so that it has been found necessary to disintegrate it in some way before washing. This is accomplished by exposing piles of ore to the weather with occasional wettings. The action of moisture and air, aided by the frequent freezings and thawings of the winter climate, soon starts the slacking and disintegration of the lumps of "blue," as the ore is called. The disintegration is carried out on inclined floors or settling grounds, where the ore is deposited after removal from the mine. After an exposure of several months, a large stream of water is turned on the piles of "blue," which are forked over at the same time. The disintegrated surfaces of the lumps are washed off and down through a sluice along with other loose disintegrated material. This leaves the "blue" in apparently hard fresh lumps, which, however, soon begin to disintegrate and crumble again. The material in the sluice is carried over a set of riffles to a settling dam, where the lump material brought down undergoes further disintegration. From the first settling dam the "blue" is washed down over riffles to a second, for final disintegration.

The sluices are made of board and have iron-plate bottoms. Iron riffles are placed at the proper places in the sluice to catch the sapphires, and clean-ups are made four or more times in twenty-four hours. The concentrates are separated in a rocker sieve into three sizes, and each grade is panned down closer over a wooden tank. The oversize left on a screen of $\frac{5}{8}$-inch mesh is carefully examined for large sapphires before discarding. The contents of the tank in which the panning is done receive further treatment on screens of two different meshes from those first used. Sapphires are picked up by hand from the coarse sizes of concentrates before shipping. The small sizes containing the culls for watch jewels are shipped in the rough. All the sapphires go to the company's office in London for cutting and marketing.

American Sapphire Company.—Through the courtesy of Messrs. John T. Morrow and C. H. Burr, consulting and attendant engineers for the American Sapphire Company, the writer was shown through the plant of that company and was assisted in the preparation of the following notes. The plant of the American Sapphire Company, operating on the same gem-bearing dike as the New Mine Sapphire Syndicate, is located in the canyon of Yogo Creek. The early work by former owners on this portion of the sapphire-bearing dike consisted of shafts and openings on the east side of the canyon. Some of these were near the edge of the bench land above, and others in the canyon walls. Prospects and shafts were also made across Yogo Canyon and along a tributary gulch to the west. Three different dikes are reported to have been located. One of these, in the bottom of the tributary canyon, was opened several years ago by a shaft about 100 feet deep, and good sapphire ore was found.

The mining of the dike rock by the present company is accomplished by drifts with stopes under the cliff on the east side of the canyon and a shaft at the mouth of the drift a little above the bottom of the canyon. This shaft was about 70 feet deep in September, 1907, and in pay ore. It was reported that the depth was about 100 feet early in 1908, and that the shaft was equipped with an electrical hoist capable of sinking to 1,000 feet. The level of the workings in the

canyon is about 265 feet below the mouth of the old shaft on the cliff. The main drift has been carried to the east nearly 500 feet, with many hundred feet of levels and stopes above. The dike is somewhat irregular in shape and contains alternate rich and barren portions. The latter seem to be due, in places, to abundant inclusions of limestone, while in other places the dike pinches around projecting portions of the limestone walls. The outcrop of the dike in the foot of the canyon wall was not at first located, since it was rather indefinite and was partly covered with large blocks of talus. A crosscut tunnel was driven from the north side until the dike was located, and from this the main drift was carried eastward on the one side, and the dike traced to its outcrop in the canyon wall on the other. A large body of pay rock, apparently over 45 feet wide, was located by the crosscut and drift. Though the relation of this ore body to the dike was not definitely known at the time of the writer's visit, it seemed to cut across the regular dike with a dip of about 40° to the east. No definite hanging wall had been located, though the pay streak was about 12 feet thick from the foot wall. This body of ore had been brecciated and the broken masses squeezed into slickensided lenses.

The mine is equipped with a track running to the mill near by. The track is protected between these points by a shed, in order that severe weather may not interfere with operations. The ore is handled in steel dump cars of improved pattern.

The method of treating the sapphire ore is quite different from that used by the New Mine Sapphire Syndicate, the ore receiving special mill treatment soon after mining. It has been found that over 50 per cent of the ore removed by blasting is fine enough for milling without disintegration by weathering. The ore direct from the mine, after passing through 4-inch grizzlies, is digested with water in heavy revolving screens. The latter discharge three classes of material, the fines or slimes, which are immediately discarded, the oversize or material still in lumps, which is saved for further treatment, and the digested matter ready for sizing and concentration. The lump material is left in stock piles to weather for a period of several months, by which time it is readily digested in the revolving screens and concentrated. After sizing, the digested material is concentrated on Woodbury jigs arranged to treat three sizes, three-fourth and three-eighth inch and 6-mesh. Two jigs are run in series for safety. These jigs were handling about 75 tons in a day of seven and one-half hours at the time of the visit, though from 200 to 225 tons could be treated in twenty-four hours.

The concentrates from the jigs, in rare cases, run as high as 30 per cent sapphire, 5 to 10 per cent being more common. The concentrates containing the watch-jewel sizes, or culls, are treated on a Blake-Morscher electrostatic concentrator and their grade brought up to between 50 and 90 per cent sapphire. The final cleaning, as with the larger sizes suitable for cutting, is accomplished by hand picking. In filling hurry orders this cleaner is of value, since it enables a large quantity of sapphire to be selected much more quickly than could be done by hand alone. On the other hand, part of the sapphire goes over with the tailings, which require more labor to pick over than the original concentrates.

The operations of the American Sapphire Company have not yet reached the capacity of the plant, since much time has been con-

sumed in perfecting the method of concentration in use and in exploratory work in the mine. The production of sapphires suitable for cutting amounted to over 100,000 carats between April and December of 1907. In addition, several thousand ounces of culls for watch jewels, bearings, and instruments of precision, were obtained at the same time.

Variegated Sapphire Company.—The auriferous placer sapphire deposits on Dry Cottonwood Creek, 16 miles N. 70° E. of Anaconda, were exploited with a dredge during 1907 by the Variegated Sapphire Company under the management of Mr. William Dodd. The deposits are located at an elevation of over 6,000 feet, nearly 1,500 feet above the valley of Deerlodge River, to which Dry Cottonwood Creek is tributary. The company owns some 2 miles of gulch land with beds of gravel 40 to 100 feet wide and from 10 to 14 feet thick. The gravels in some of the gulches to the side of the company's land and in the flats below are also reported as carrying sapphires.

The country rock in the region around the mine is a quartz porphyry, in places nearly a biotite granite. This porphyry is rather fine grained and composed of quartz and feldspar phenocrysts, with biotite laths and crystals in a ground mass. The quartz occurs in clear, glassy crystals and rounded grains, some of them fractured, thickly scattered through the rock. The feldspar, chiefly a plagioclase, has largely decomposed to kaolin in the surface rock examined. This kaolinization has taken place both within the crystals, on their exterior, and in the ground mass. The biotite also seems to have been partially hydrated, and in thin section under the microscope has a low birefringence and a strong dark-green to brownish-black pleochroism.

The source of the sapphires is not known. Mr. Dodd reports their occurrence farther up the gulch than the part examined, in a rock like the porphyry described above. The gravels in the gulch consist chiefly of blocks of porphyry, some of them rounded into cobbles, others flat and slab-like with but partially rounded corners. The overburden or top of the deposit, consisting chiefly of black muck with but little gravel through it, is 3 to 4 feet thick.

The dredge used by the company is of the bucket type, and has a capacity of 750 cubic yards in twenty-four hours. It is operated by a steam engine, and has a dynamo for its electric-light equipment. The material from the dredge buckets goes to a revolving screen from which everything over 1 inch in diameter is separated and turned into the pond under water at the back of the dredge, while everything under 1 inch in diameter is run over 56 feet of riffles. The débris from the sluice and the riffles is piled on the coarse material at the back of the dredge. In this way a dam is built which retains the water in the pond on which the dredge floats. By excavating before and constructing a dam behind, the dredge will be worked up the gulch. The grade of the gulch is not light, and the flow of the creek during the summer is quite small. The dredge cuts a square face in the gravels across the gulch. The overburden is first removed for a width of 6 feet upstream, being run directly through the dredge without washing. Mercury is placed in the riffles to catch gold, and clean-ups are made weekly. The sapphire concentrates are washed from the sluices of the dredge into a bin and are later sieved and panned down.

The gold recovered from concentrates is mostly fine, though nuggets worth several dollars have been reported. It is said the value of the gold obtained is sufficient to pay operating expenses. The larger part of the sapphire, either on account of small size or poor color, is suitable for mechanical purposes only, as watch and meter bearings. Some of the sapphires are suitable in size, quality, and color for cutting as gems. The predominant colors of the Dry Cottonwood sapphires are deep and light aquamarine and pale yellowish green. Other colors are clear and smoky blue, light and dark topaz yellow, straw yellow, yellowish green like olivene, light and dark pink; some stones are nearly ruby red, lilac and pale amethystine, and some are colorless. The pleochroism of some of the sapphires is marked, the same crystal appearing greenish when viewed across the prism and blue through its length, or pale and deeper pink, as the case might be. It is not unusual to find aquamarine-colored stones with a pink spot in the center. This combination furnishes an attractive gem when cut. A feature of the deep pink colored sapphires is their rich and beautiful color under artificial light, even when not very attractive in natural light.

The sapphires occur in rough crystals, often with curved faces, as irregular rounded masses, and as waterworn pebbles. The surfaces of those which are not waterworn are very much etched and corroded. One yellowish-green sapphire crystal, weighing a little over 4½ carats, had very much the shape of a rough diamond crystal. This effect is largely due to the fact that the development of the basal and rhombohedral faces produced a form resembling an octohedron. This apparent octohedral form along with marked curvature of the faces and peculiar etching produces the effect described. The proportion of waterworn sapphires is not large, and only a few show a large amount of wear. A few red and cinnamon-red garnets, mostly small, are found in the concentrates with the sapphires.

American Gem Mining Syndicate.—The operations of the American Gem Mining Syndicate for sapphires were confined to two gulches on the north side of the West Fork of Rock Creek, in Granite County, about 15 miles southwest of Philipsburg. These gulches are nearly a mile apart and are known as Anaconda Gulch on the west and Meyer Gulch on the east. Both drain to the south, Anaconda Gulch with a rather steep grade cutting through a small stretch of flat country along part of its course. Sapphires are said to have been found in the gulches and scattered over the surface of an area of about 2 square miles in this region.

The country rock around the sapphire deposits consists of coarse and fine grain porphyry, porphyritic tuff, conglomerate, quartzite, siliceous slate, and black limestone, the geological relations of which have not been worked out. In and near Anaconda Gulch the rocks underlying parts of the sapphire deposits are conglomerate, porphyritic tuff resembling conglomerate where the inclusions are plentiful, and porphyry. The bed rock in the lower part of Meyer Gulch is a dense, siliceous slaty rock of purplish color with a little black limestone. To the west of the sapphire-bearing deposits on the flats near Anaconda Gulch is rather coarse porphyry, probably granite porphyry, and to the north is fine porphyry. Ledges of tuff or conglomerate outcrop at one place on the flats where sapphires have been

worked, and the gravels over part of the flats contain angular to subangular débris of porphyry, tuff, and conglomerate.

The porphyritic tuff is composed of feldspar and glassy quartz phenocrysts in a fine slate-gray matrix with inclusions of quartzite and other material. The inclusions observed range from an inch or two down in size, and the phenocrysts average about one-sixteenth of an inch across. The conglomerate at the sapphire deposits is composed of pebbles of quartz, red, brown, and gray sandstone and quartzite, gray and black chert, and a serpentine-like material, with a siliceous cement, the whole containing decomposed feldspar fragments throughout. The pebbles range in size from about 2 inches down. About a mile to the east of the mine is a bed of very coarse conglomerate forming cliffs 60 to 70 feet high along the north side of the West Fork. The pebbles of this conglomerate are composed of sandstone, quartzite, siliceous slate, and chert, with a compact, hard, red, jaspery matrix. These pebbles are well rounded and range in size up to 10 and 12 inches in diameter. While a number of them are very similar to those of the finer conglomerate at the sapphire mine, the frequent quartz pebbles of the latter seem to be lacking. There are pebbles and fragments of light-yellowish and greenish-gray to green serpentine-like mineral included in the coarse conglomerate to the east of and in the conglomerate and tuff at the sapphire mine. Large blocks of apparently the same material were found on the flats at the mine. The latter consisted of a fine-grained greenish-gray matrix with translucent dark-green blocks, resembling crystal fragments, included in it. Both the matrix and the inclusions were soft and like serpentine. In thin section the greenish inclusions were seen to be very fragmentary with a light, porous, kaolin-like looking material between the fragments. The latter were composed of many small, doubly refracting particles and fibers extinguishing at all angles.

The gravels in Anaconda Gulch vary from 30 to 100 feet in width and from a few inches to 8 or 10 feet in thickness. At the bends and in some of the hollows along the gulch gravel bars extend up the hillsides short distances. On portions of the flats along the gulch gravel beds occur, and good deposits of sapphire are reported to exist in channels leading to the gulch. At one place on the flats the gravels, and probably also the decayed tuff or conglomerate, have been washed for sapphires over an area of a number of feet square. The gravels in Meyer Gulch are from 30 to 40 feet wide in the lower part and from 100 to 200 feet wide farther up the gulch. In thickness they vary from a foot or two up to 8 or 10 feet, and are probably as much as 5 feet thick over a large portion of the area.

The gravels in both Anaconda and Meyer gulches are sluiced down with small hydraulics. The first part of the sluice is over bed rock and from this portion the bowlders and coarse débris are forked out. The finer material is then washed down through board sluices over cross riffles. The latter are removed and cleaned up each day. In Meyer Gulch the tailings from the riffles are carried through several hundred yards of wooden sluice to remove the waste from the gulch near the workings. This sluice has riffles with bars parallel to its length, largely to protect the boards of which it is constructed, though partly to catch sapphires that have washed over the cross

riffles. The parallel riffles are cleaned up at wide intervals of time. All of the concentrates are further cleaned on a jig operated by a small water wheel. The concentrates from the jig are oven-dried and shipped for picking. Gold is also saved from the concentrates. The tailings from the jigs contain rutile in elongated, much water-worn pebbles, scaly hematite in quartz, garnet, corundum, pyrite, manganese ore, siliceous iron pebbles, and other minerals.

The sapphires from the Rock Creek region are principally used for mechanical purposes, though some are of good color and quality and of sufficient size to be cut as gem stones. The prevailing color is some shade of green, as the yellowish and bluish green of beryl and aquamarine. Blue, yellow, purple, pink, and red sapphires are found, however. The greater part of the sapphires are shipped to Switzerland, where they are cut for use as watch jewels and for other bearings.

COLORADO.

Mr. C. A. Beghtol reports the discovery of sapphire in the matrix in Fremont County, Colo., by a prospector named Weston. The latter would not reveal the locality.

INDIA.

Kashmir.—The production of sapphire during 1906 from the Kashmir mines[a] amounted to 2,837 carats, valued at £1,327.

Burma.—In the operations of the Burma Ruby Mines Company during the year closing with February 28, 1907, sapphire valued at £1,132 was produced.[a] The quantity of sapphire produced is not given separately, but is combined with that of spinel and ruby, the total of which amounted to 326,855 carats.

CEYLON.

A blue sapphire weighing 466 carats after cutting and polishing is reported to have been found in Ceylon during 1907.[b] If the report is true, this is the largest blue sapphire on record, and if the stone is of good color and free from flaws it should be worth several thousand dollars.

AUSTRALIA.

Queensland.—The value of the sapphire production of the Anakie field during 1907 is given at about £40,100,[c] as compared with £18,000 in 1906. The miners sell their sapphires to resident dealers,[d] who in turn ship them to merchants in Europe. Probably 75 per cent of the stones go to Germany. The average price per ounce paid for sapphires during the last five years has been approximately as follows: 1903 and 1904, 15 shillings; 1905, 15 shillings to £1; 1906 and 1907, £1 4s. The sapphires are graded into three classes—first-class blue, second-class blue, and "machine stones," named in order of their value. The use made of the "machine stones" is not definitely known, though it is supposed they are applied in mechanical apparatus.

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[a] Rec. Geol. Survey India, vol. 36, pt. 2, 1907.
[b] Manuf. Jeweler, November 7, 1907; from London Standard.
[c] Mining Jour., London, March 14, 1908.
[d] Mining Jour., London, February 22, 1908.

SMITHSONITE.

Translucent, apple-green smithsonite, not only furnishing beautiful cabinet specimens but cutting pretty gems, has been found in large masses in the Magdalena mining district, New Mexicco. This smithsonite occurs in the Kelly mine, which is being developed by the Tri-Bullion Smelting and Development Company. It was found in a zinc vein in a cavity or vug several feet wide and 25 feet long, which it lined and partly filled with odd-shaped masses. The surface of the smithsonite masses has a mammillary structure which is drusy with the edges of many small projecting crystals. The mineral assumes odd shapes and sometimes nearly a globular form. One specimen, seen in the New York office of the Tri-Bullion Company, was roughly about the size and shape of the head and bust of a man. It had a beautiful light-green color and was covered with drusy mammillary lumps an inch or two across.

This green smithsonite occurs in shells or layers, up to an inch or two in thickness, coating rough, irregular masses of typical dry bone or carbonate zinc ore. The shells of smithsonite have a columnar structure across them, with a slight radial arrangement of the columns. Ordinary smithsonite or zinc carbonate is colorless or white. This material contains variable quantities of a copper salt, which give it a beautiful green color. The copper stain is not evenly distributed through the mineral, but occurs in layers parallel with its surfaces. This smithsonite is being cut and sold as a gem in some of the Western States. It yields handsome cabochon stones similar to chrysoprase, though of course not so hard and therefore less valuable than that mineral. Mr. Hart, of Manitou, Colo., reports that the rough mineral for gem purposes brought from $2 to $5 per pound at Magdalena.

SPHALERITE.

Dr. George E. Ladd reports that sphalerite crystals from the zinc-lead mines of Missouri are used locally in jewelry without cutting. The clear, rich, resin-colored crystals make handsome stick pins. The mineral is too soft, however, for extensive use.

SPODUMENE.

KUNZITE AND HIDDENITE.

United States.—There was a large production of lilac-colored spodumene or kunzite in the southern California gem region during 1907. The output of gem spodumene amounted to about 125 pounds of selected material, part of which was pale green, colorless, and yellowish. The production came from the Pala Chief and the Caterina mines, near Pala, and the Mack mine, near Rincon, all in San Diego County.

The development for the emerald-green spodumene or hiddenite deposit in North Carolina was described under "Beryl." Further work on the lilac and pale-green spodumene deposit at Andover, Oxford County, Me., has yielded mineral of good color, though clear only in small patches. Mr. F. G. Hillman reported surprisingly beautiful gems cut from material that had been pronounced valueless by two dealers in precious stones.

Madagascar.—Mr. Albert Dabren, mining engineer of Madagascar, reports the discovery of gem kunzite and hiddenite on that island. In a personal letter to the writer, dated Tananarivo, May 1, 1908, Mr. Dabren states that the material is comparable with that of California and North Carolina in beauty.

TOPAZ.

UNITED STATES.

Topaz was produced in Utah, California, Texas, Maine, and New Hampshire during 1907. Prof. F. W. Clarke mentions an occurrence of topaz on Baldface Mountain, near North Chatham, N. H., where faintly bluish and colorless crystals, suitable both for specimen and cutting, are found. This locality is only a few miles from the Stoneham, Me., topaz locality.

Texas.—The production of topaz in Texas came from a new locality, near Streeter, Mason County, and was reported by Mr. R. L. Parker to amount to about 20 pounds. Part of this topaz was found as pebbles in the drift of a small branch and part in place in pockets embedded in yellowish clay, associated with crystals of smoky quartz, tabular feldspar, and mica. Mr. Parker describes the topaz as varying from colorless to white, bluish, greenish, and amber in color. Of three specimens sent to the Survey, one is a cleavage fragment of a waterworn crystal, colorless, and perfectly clear; another crystal is perfectly clear with a slight bluish tint; and the third, a large crystal weighing about 4½ ounces, is clear in portions, with a delicate bluish-green tint. It is probable that very beautiful material will be obtained from this locality.

Though well supplied with faces, the two crystals available for examination apparently presented no new forms. The forms determined with reasonable certainty by hand measurements were the prisms m(110), l(120), and g(130), brachy-pinacoid b(010), macrodome h(203), brachydomes f(021) and y(041), and pyramids u(111), v(121), o(221), and i(223). The character of the crystal faces varies considerably on the two crystals. Some are polished; others are clouded, etched, and striated.

California.—The production of topaz from California came from the gem mines 4 miles N. 75° E. of Ramona, San Diego County, and principally from the Little Three mine at this locality. These mines produce, besides topaz, hyacinth-colored garnet, tourmaline, quartz, and albite or clevelandite. Some of these stones yield rich gems, while others form beautiful cabinet specimens. The mines from which they are obtained are described under "Gem minerals of southern California."

TOURMALINE.

UNITED STATES.

The production of tourmaline amounted to about 2,140 pounds of rough gem crystals. California contributed the bulk of the production, and Colorado, Maine, and Connecticut made up the remainder. The greater part came from the mines of the Himalaya Mining Company, the Mesa Grande Gold and Gem Mining Company at Mesa Grande, San Diego County, and the Pala Chief mine at Pala. The mines of the Royal Gorge region, Colorado, operated by C. A. Beghtol & Co., were the next largest producers. Mr. J. D. Endicott reports

the discovery of a new tourmaline deposit in pegmatite inclosed in garnetiferous mica schist in Fremont County, Colo. A new deposit of tourmaline was reported from the Pala region, San Diego County, Cal., by Mr. John W. Reed, late in 1907. A pocket opened in this deposit contained over 150 crystals, some 2 or 3 inches in diameter and several inches long, which had a lavender color. Several tourmaline mines in California are described under the "Gem minerals of southern California."

INDIA.

The production of tourmaline from the Ruby Mines District of Burma during 1906 amounted to 193 pounds, valued at £1,001, as compared with 161 pounds, valued at £1,500 in 1905.[a] Mr. E. C. S. George, deputy commissioner of the Ruby Mines District, describes the workings for tourmaline [a] about a mile east of Maingnin. These deposits were worked by the Chinese about 150 to 200 years ago. According to local tradition they were again opened temporarily by Kachins about forty years ago. About 1885 the deposits were reopened and more systematically worked until 1895 under Pir Seinde. Since 1899 they have been worked by licenses, and during the last three years this locality has produced about £200 worth of tourmaline annually.

The tourmaline occurs in soft, decomposed, granitic veins, generally covered by a thick layer of jungle soil. Isolated crystals are sometimes found in the yellowish earth associated with the granite or the red soil capping it. The discovery of the deposits made from shafts 4 or 5 feet square with underground workings is almost entirely accidental. Some of the shafts are about 100 feet deep, which seems to be the limit of the native skill. The tourmaline is sorted into three classes: (1) Best pink rubellite; (2) darker colored crystals, lower part brown or black; (3) fragmentary crystals of any color, or imperfect small crystals. The best varieties bring from £80 to £100 per viss (3.65 pounds).

TURQUOISE.

There was a production of nearly 600 pounds of rough selected turquoise and of nearly 3,000 pounds of turquoise matrix during 1907, from Arizona, Nevada, Colorado, New Mexico, and California. The greater part of the production came from the mines near Mineral Park, Ariz. The output from Colorado came from the mines near La Jara, Conejos County, operated by the Colorado Turquoise Mining Company. This company reported development work by two tunnels 200 feet and 100 feet long, respectively, and four shafts 105 feet, 97 feet, 70 feet, and 50 feet deep, respectively. Mr. E. H. Davis, of Mesa Grande, Cal., mentions the discovery in December, 1907, of a turquoise deposit in the Colorado desert on Carrizo Creek. Turquoise seams in a dark matrix are especially suitable for cameo coverings, and some of the native material has been used with excellent results for this purpose by Messrs. F. J. Essig, of Chicago, and William Petry, of Los Angeles. This turquoise cameo stone comes from Esmeralda County, Nev., and consists of good blue turquoise in seams an eighth of an inch or more in thickness in a dark gray chalcedony matrix. The latter furnishes a good background for the turquoise carving.

[a] Rec. Geol. Survey India, vol. 36, pt. 2, 1907, p. 83

NEW MEXICO.

Turquoise is known to occur at several places in the Burro Mountains of Grant County, N. Mex. A description of one of these deposits—that of the Azure Mining Company, about 15 miles southwest of Silver City—with notes on the geology of the surrounding region, has been given by Mr. Edward R. Zalinsky.[a] The Azure mine, the American Gem and Turquoise Company mine, one-half mile southeast, and the Porterfield Turquoise Company mine, one-half mile south of the Azure mine, were briefly visited by the writer during the fall of 1907. The following description has been prepared from Mr. Zalinsky's article and the writer's notes:

During the last part of 1907 a small amount of work was done on the Azure mine, opening up the lower levels and preparing to push developments during 1908. The mine had not been operated since 1905. The American Gem and Turquoise Company mines also have been idle for the last few years. The Porterfield turquoise mine was not worked during 1907, though there was a large production from small excavations in 1906.

The country rock of the turquoise region is granite which presents various phases in texture, composition, and degree of alteration. The greater part of the granite has a porphyritic texture, which varies from coarse to very fine. Much of this granite has undergone such extensive kaolinization that it is often difficult to determine the constituent feldspathic minerals. The texture varies considerably and in some places is finer grained and more porphyritic than in others. A common variety of the granite has coarse pink feldspar phenocrysts. A thin section cut from a specimen of this granite collected at the Copper King mine, about one-third mile southwest of the head of the Azure mine, contained orthoclase, a plagioclase, quartz, biotite altering to chlorite, magnetite, and zircon. Another section cut from a specimen from near the east wall of the Azure vein contained orthoclase, a little plagioclase, probably albite, and quartz in grains and veinlets. The feldspars were partially kaolinized and the kaolin much stained with limonite. Another form of occurrence is a spotted porphyritic granite with phenocrysts of orthoclase and plagioclase 2 or 3 millimeters square. A thin section from this variety of rock at the Porterfield mine contained orthoclase and plagioclase in phenocrysts and biotite shreds scattered through a groundmass of feldspar and quartz. All of the feldspars were partially kaolinized.

Mr. Zalinsky describes the occurrence of mica-andesite porphyry stocks and andesite dikes of pre-Tertiary and Tertiary age. It was probably during the intrusion of these bodies that the rock of the region was fractured and mineralized. The turquoise deposits adjoin the copper deposits of the Burro Mountains on the northwest, and copper staining is present throughout their extent.

Azure turquoise mine.—The Azure mine has been worked on an immense scale by an open cut that is about 60 feet deep in its deepest portion, from 70 to 100 feet wide, and about 200 yards long, with adits on two levels below the open work. The vein is in a badly fractured zone and strikes about northeast with a dip of 45° to the southeast; it is about 40 feet wide, though locally over 60 feet wide. The joints produced during fracturing dip both parallel

[a] Economic Geology, July–August, 1907, pp. 464–492.

to the vein and across it to the northwest. Slickensides and evidence of movement are more pronounced on the fissures parallel to the vein, and two such prominent fractures form the walls of the vein through part of its extent at least. The country rock is porphyritic granite, badly altered through kaolinization, portions of which form the mass of the vein. A large amount of silicification has hardened the rock in many places so that it does not resemble ordinary decomposed granite. This silicification is represented by the deposition of quartz in part throughout the rock and in part in seams and veinlets cutting it at all angles.

Turquoise occurs as veins and veinlets filling the joints and fissures in the rock and as nuggets. In places these veinlets are mere films, and in others they are as much as three-fourths of an inch thick. Part of the turquoise is found in groups of small rounded masses resembling nuggets, fitted roughly together though separated from one another by kaolin or clay and enveloped in it. These groups of nuggets generally fill a flattened lenticular-shaped pocket in one of the veinlets. The best turquoise came from a portion of the vein known as the "Elizabeth pocket," which extends from the second level to the surface, a height of 40 to 60 feet, and may include a width of 40 feet and a length along the vein of 150 feet. The vein rock near this pocket is cut by an unusually large number of quartz seams and veinlets up to a half inch wide. These contain crystal-lined cavities in places, and veins of turquoise sometimes contain quartz crystals penetrating them. The quartz veinlets sometimes give place to turquoise veinlets or include patches of turquoise. Where portions of the rock are less altered and pink feldspars occur, turquoise of a bright blue color is found. Turquoise veinlets of different shades of color are found crossing each other, indicating different periods of deposition and different sources of material.

Good turquoise was found at other places in the vein than in the Elizabeth pocket. To the northeast of this pocket much of the turquoise had a greenish cast, while still farther along good blue variety was more plentiful. To the northeast of the open cut the Azure mine did not yield much turquoise of good color in a drift several hundred feet long. To the southwest of the open cut the vein is readily traced for several hundred yards up Morrills Canyon. It contains very little turquoise, however, but has been proved to carry fairly rich copper ores. Mr. William R. Wade, who has directed the openings on this vein for copper, reports that a little turquoise was found in the Copper King mine at a depth of 410 feet. In the workings at the Azure mine the best turquoise was found at depths of less than 100 feet. Pyrite or sulphides were not observed associated with the turquoise, though the wall rocks are colored red with hematite in places. Where the feldspars of the rock have been the most extensively kaolinized turquoise is found mostly in nugget form. In less altered rock hard vein turquoise is found, and both varieties are found in moderately altered rock.

Mr. Zalinsky mentions the various colors found in turquoise at the Azure mine and the associations with other minerals and matrix. Nearly all shades of blue and green occur—dark blue, sky blue, light blue, bluish green, light green, and dark green—and in some cases reddish-brown, chocolate, and violet-colored material has practically the same composition as turquoise. A combination of colors

in the same piece is not uncommon, especially in mottled matrix, as bright blue spots or lines in paler turquoise. The mineral halloysite is associated with turquoise in olive-green and grayish masses and in nugget form similar to turquoise nuggets. Halloysite is opaque to translucent and has a waxy luster. When moist and fresh from the mine the halloysite has about the consistency of candle wax. It hardens and cracks on exposure to the air, however, though it does not become so hard as turquoise. Among numerous associations the following were noted: Pale-blue vein turquoise with a network of yellowish-brown hydrous aluminum phosphate streaks; blue-white vein turquoise containing open cracks and streaks of darker material; light-blue vein turquoise containing yellow spots of phosphate, quartz grains, and darker veinlets of purple and blue parallel to the walls.

The turquoise from the Elizabeth pocket is probably the finest ever found in the world. Much of it is of a deep blue color, slightly translucent, and over 6 in hardness, so that it makes a fine wearing gem. The cut gems of good quality from the Azure mine are marked with a circle on the lower side, and such stones are guaranteed to hold their color for a number of years or to be replaced. Mr. Zalinsky states that the Azure mine has produced turquoise to the value of several million dollars since 1891.

Mr. Zalinsky suggests that the turquoise was formed in the vein where copper-bearing solutions, rising in fissures with a northwest dip, crossed phosphate-bearing solutions rising in fissures parallel to the vein with a southeast dip. In support of this theory the occurrence of such copper minerals as malachite and chrysocolla in the copper fissures above the supposed phosphate fissures is cited. It is thought the phosphoric acid of the turquoise was derived from the decomposition of apatite in the original granite and the alumina from the decomposition of the feldspar of the same rock. Where copper was supplied in excess, the turquoise runs toward green in color. The proper proportion of copper gives the best bright blue gem of greater hardness than where the copper was not present in sufficient quantity. In the latter case the turquoise is of pale color and inferior hardness, and apparently this variety grades into simple phosphate of aluminum.

American Gem and Turquoise Company mines.—The operations of the American Gem and Turquoise Company were upon the deposits in the Parker mine and near the prehistoric workings about 200 yards to the northwest. At the latter place the recent work consists of two tunnels, of about 50 and 60 feet in length, driven in from a small open work at the outcrop on a hillside. One of these tunnels running southwest followed prominent seams, which carry turquoise in places and dip about 50° to the southeast. The other tunnel cut across the direction of the prominent seams and appeared to be exploratory work. The country rock is typical quartz porphyry with prominent glassy quartz phenocrysts and badly kaolinized feldspar crystals.

Mining at the Parker mine was accomplished principally by open cuts, of which two are fairly large. The one to the north was made in a gully running east, and is nearly 100 yards long and 10 to 25 feet deep. The country rock is hard quartz porphyry like that near the prehistoric workings. A number of seams carrying turquoise cross

the open cut in a northeast direction with southeast dips. Other seams, and one especially prominent seen in the end of the cut, run nearly east and west with a high northerly to vertical dip. Turquoise occurs in films, seams, nuggets, and irregular masses in the matrix. The prominent seam mentioned was from 2 to 6 inches thick, and carried pale turquoise and matrix in masses of nearly equal thickness. Much of the turquoise in this seam is too soft and of too poor color to be of great value; part, however, would yield good matrix gems.

The openings farthest south consist of irregularly shaped open work with a small amount of tunneling. The main cut is nearly 50 feet deep on one side and probably 100 feet across. This cut is situated on the contact of the typical quartz porphyry on the northeast and the altered country granite on the southwest. The rock is jointed in different directions, some of the seams running northeasterly. The turquoise occurs in films and veinlets in many of the joints, and some of a fine bright blue color nearly a quarter of an inch thick was seen in the open cut.

Part of the turquoise from these mines is of the same high grade as much of that from the Burro Mountains. The guaranteed cut gems of this company are marked with a cross (x) on the lower side.

Porterfield Turquoise mine.—The Porterfield Turquoise mine is on the west side of St. Louis Canyon, on each side of the mouth of a small gully. The work at this mine has not been extensive and consists of several tunnels and shafts with small open cuts and prospect pits. Two of the deeper shafts are between 40 and 50 feet deep, and the longest tunnel is nearly 170 feet in length. Turquoise of the best quality was found most plentifully during 1906 in irregular open work near the bottom of the gully.

The country rock at the mine consists of different types of granite porphyry. A prominent type has large crystals or phenocrysts of red orthoclase through a quartz and biotite matrix, and approaches a granite in texture. Another type is a finer spotted porphyry, composed of orthoclase with some plagioclase and quartz phenocrysts in a groundmass of feldspar and quartz. Biotite is locally present in quantity in small six-sided crystals generally badly altered to chlorite. Another type is a quartz-feldspar granite, somewhat porphyritic, in which biotite and similar minerals are lacking. In the majority of these rocks the feldspars have been partially kaolinized, while abundant silicification has taken place. The latter is represented by much secondary quartz binding the particles of rock more closely together and in seams cutting the rock in various directions.

Turquoise has been found in prospects in a belt about 100 yards wide and over 200 yards long in a direction east of north and west of south. This area is marked by numerous joints, of which many prominent ones strike northeast, though others cut across this direction at various angles. The turquoise occurs in seams, veinlets, lenses, and groups of nodules or nuggets in lens-shaped masses. Among the minerals associated with turquoise the most common is a white, koalin-like clay which coats the nuggets and in places forms an important part of the filling of seams. Among other minerals observed associated with turquoise and in turquoise-bearing seams were hematite, quartz, limonite, hyalite opal, chalcedony, and greenish, waxy halloysite, which in places assumes the form of nuggets like turquoise. The turquoise occurs in seams running in various

directions, the larger veinlets often having stringers extending out in seams crossing them. The joints and seams in the vicinity of turquoise-bearing ground often show indications of turquoise in the form of blue, bluish-green, green, yellowish-green, and whitish coatings or stains.

Choice lots of turquoise that range from deep robin's-egg blue to blue of pale shades and that would yield one color gems of 10 to 20 carats (or even of 30 carats) are reported to have been obtained from this mine. The largest yield of turquoise of one color is in stones of 1 to 10 carats, while considerable matrix material and mottled turquoise are reported to have been found. Mottled turquoise presents a number of variations of light-blue turquoise speckled with dots of deeper blue. In one specimen seen the dark blue mottling consisted of small dendritic masses resembling the markings in moss agate. Judge M. M. Porterfield, owner of the mine, states that the deep-blue stones of finest quality when cut bring from $1 to $10 per carat for those under 10 carats in weight and $10 or more per carat for those weighing over 10 carats. The matrix stones bring from 25 cents to $1 per carat, and the mottled turquoise brings a little more than the matrix. The Porterfield turquoise when cut is marked with a cross (x) on the lower side, as are those of the American Gem and Turquoise Company. With better facilities for marketing, the production of the Porterfield mine could probably be considerably increased.

UTAHLITE AND AMATRICE OR VARISCITE MATRIX.

Amatrice is the new name given to utahlite or variscite with its associated matrix, as now mined and cut by the Occidental Gem Corporation of Salt Lake City. The word "amatrice" is a combination of the first letter of the word American and of the word matrice, and is intended to indicate that the gem is a matrix stone of distinctly American origin. During 1907 the Occidental Gem Corporation worked the deposit of utahlite in the Stansbury Mountains, Tooele County, Utah, described by Dr. George F. Kunz in this report for 1905. The company reports about 100 feet of tunnel opened and 30 feet of cuts made. The gem occurs in nodular form with a coating of chalcedony and other minerals. The production of finished gems from the rough material mined amounted to about 20,000 carats.

Amatrice is composed of variscite, wardite, and probably other allied minerals, chalcedony, and quartz. Variscite and wardite occur together and both are hydrous phosphates of aluminum with colors ranging from deep grass green to paler shades of green and slightly bluish green. Both minerals are compact and tough, the hardness varying from a little over 4 in variscite to about 5 in wardite. The matrix consists of chalcedony and quartz with other minerals, among which are yellowish gray and white phosphates, probably in part variscite or allied minerals, sometimes deposited around portions of green variscite or banded with chalcedony. In both the variscite or wardite and the adjoining matrix there is an oolitic texture with the shot-like masses recemented together with mineral of a different shade of color. Much of the chaledony is dull and chert-like, with the color varying from dark red and yellow brown to buff and gray.

The charm of amatrice is due to the wide range of colors of the several minerals composing it and the numerous combinations these colors make with one another. These combinations of color are due

to several causes, among which are the deposition of the different minerals or colors in agate-like bands either around a fragment of other mineral as a core or filling cavities however formed, and the brecciation of both the variscite and matrix with subsequent deposition of other minerals or of the same mineral with different shades of color in the cracks and seams. Among the odd combinations of color may be mentioned light-green with deep-green "cobweb" or "turtle-back" mottling, with or without other colored matrix; dark brown or yellow matrix in seams and irregular masses with light or dark green background, or vice versa; yellow, gray, and white matrix inclosing or inclosed in green of varying shades.

Mr. Don Maguire reports a considerable production of utahlite, or chlor-utahlite, from the Camp Floyd mining district, Utah County, about 2 miles south of Mercur gold mine. This locality has been described by Dr. George F. Kunz in his reports on the production of precious stones for 1894 and 1904.

GEM MINERALS OF SOUTHERN CALIFORNIA.

Mining for precious stones in San Diego County was actively pushed during the first part of 1907, and a considerable output was obtained. During the last half of the year operations were but intermittent or suspended at a number of the mines. The principal production of gems came from around Mesa Grande and Pala, though there was a smaller production from Rincon, Ramona, Riverside, Oak Grove, etc. At Pala varying amounts of work were done at the Pala Chief and Tourmaline Queen mines, owned by the Pala Chief Gem Mining Company; at the Stewart Lithia mine, or its extension, owned by the American Lithia Company; at the Caterina, Hiriart, and Naylor-Vanderburg mines on Hiriart Mountain, owned by the Sickler Gem Mining Company; and on claims on the north side of Hiriart Mountain. At Rincon there was an output of tourmaline and kunzite from the Mack mine. At Mesa Grande work was done at the mines of the Himalaya Mining Company, the Mesa Grande Consolidated Gold and Gem Mining Company, the San Diego Gem Mining Company, the Native Gem Mining Company, the J. M. Cota mine, the Trail mine, and the Rose Quartz mine. At the mines on the hill 4 miles N. about 70° E. of Ramona the Little Three, Hercules, Lookout, Reliance, and Mars claims and the Daggett mine were tested or worked.

PALA.

Stewart Lithia mine.—The Stewart Lithia mine is located about a mile and a half northeast of Pala on the end and along the east side of a ridge or spur of a mountain. The vein consists of a pegmatite mass nearly 50 feet thick in places and outcropping prominently for a third of a mile or more; part of the outcrop to the north belongs to the Messrs. Labaugh. It has a northerly strike with a gentle dip (10° to 15°) to the west. The principal work has been to the south for lithia minerals at the point of the spur where the pegmatite ledge outcrop extends from the east side to the west side. Tunnels have been cut through the ridge exposing large masses of lepidolite and amblygonite. Compact lepidolite can be obtained here by the hundred tons. Later work at the Stewart mine consists of several cuts

and tunnels to the north of the main workings and at different points along the ledge. In some of these openings the lepidolite was more coarsely crystallized though less plentiful than in those to the south, and both gem tourmaline and kunzite were found. Tourmaline occurs in coarse pink crystals in portions of the vein. In places these crystals have badly altered to a soft substance resembling pink talc or kaolin in feeling and consistency. This is doubtless the halloysite clay described by G. A. Waring[a] in his paper on the pegmatite veins of Pala, San Diego County. The occurrence of lepidolite in the pegmatite is quite irregular. In places the ledge has ordinary pegmatite at the top, called "capping," and containing much black tourmaline in crystals through it. The lithia and gem minerals occur in large pockets or masses scattered irregularly through the pegmatite. Defunct and unaltered tourmaline and kunzite occur associated with or near masses of lepidolite. In these places the feldspar and other minerals occur in large crystals or masses, and graphic pegmatite is common. Crystals of feldspar 6 and 8 feet long were seen in one of the gem-bearing portions. The lower portion of the pegmatite is thought to be barren and is finer grained than the upper.

Tourmaline Queen mine.—The Tourmaline Queen mine lies near the top on the east side of the same mountain as the Stewart mine, and about one-half mile northwest of it. Beautiful pink tourmaline, green in some portions, has been obtained at this mine, along with the feldspars, lepidolite, black tourmaline, garnets, etc. The main ledge at this mine is 10 to 15 feet thick, though at the place opened it appeared to be only a foot or two thick. The principal work consists of two open cuts of but moderate size.

Pala Chief mine.—The Pala Chief mine is nearly 1 mile east of the Stewart mine, near the top of a knob on the opposite side of a valley. The pegmatite ledge at this mine is from 15 to 20 feet thick, apparently lying on and about parallel with the surface of the hill. It has been worked by an open cut about 100 yards long and from 6 to 25 feet deep in a direction north of west and south of east. The pegmatite contains considerable black tourmaline and graphic granite through it. The gem-bearing portions or pockets contain lepidolite. Both kunzite and tourmaline are found in some of the pockets, though the openings at the western end of the cut have yielded more tourmaline than kunzite. A large part of the kunzite of southern California has been obtained from this mine.

Caterina mine.—The Caterina mine is located at the foot and on the south side of Hiriart Mountain, about 2½ miles north of east of Pala. There is a large pegmatite ledge at this mine striking in a northerly direction with a dip of about 30° W. The lower part of the ledge consists of a fine-banded quartz-garnet rock. The principal work consists of an open cut with an incline and drift from it. A large gem-bearing pocket, 6 or 8 feet thick and followed down about 30 feet on the incline, has been opened. At one place near the bottom the pocket was pinched down by a mass of crystal quartz to a thickness of 4 feet, but opened out below it. The pocket contains much crystal quartz, pink clay, and partly decomposed spodumene crystals. The spodumene crystals were of large size, and have decomposed to

[a] American Geologist, June, 1905.

whitish and pinkish clay of tallow-like consistency, or have only partly decomposed and still contain kunzite of good color. Some of the spodumene crystals were 6 to 12 inches thick and a yard or more long. Part of the tourmaline in the pegmatite at the Caterina mine has a deep indicolite blue to nearly black color.

Vanderburg mine.—The Vanderburg claim lies on the east side and near the top of Hiriart Mountain, and is probably on the same ledge as the Caterina. In the open cut on the outcrop it is said a perfect kunzite crystal weighing 1½ pounds was found. A crosscut tunnel has been run in for a distance of 150 feet, 35 feet below the outcrop, and good kunzite was found where the ledge was cut. The latter appears to strike north with a westerly dip and is possibly 35 feet thick.

Hiriart mine.—The Hiriart mine is but a few hundred yards east of the Caterina mine. The work consists of an open cut with a drift about 75 feet long. The pegmatite ledge is from 2 to 4 feet thick and strikes N. 15° E. with a dip 30° W. The crystallization of the minerals was in part perpendicular to the walls of the "vein." The gem minerals are blue and green with some pink tourmaline, associated with lepidolite, quartz, and albite crystals.

RINCON.

Victor beryl mine.—The Victor beryl mine is in a ravine just east of the little village in the Rincon Indian Reservation. The pegmatite is about 6 feet thick and strikes west of north with a dip of 45° W. The crystallization of the pegmatite in the interior of the vein is quite coarse, and there are many small pockets. These pockets contain smoky quartz and beryl, of which part is handsome aquamarine. The vein has been worked by stripping and removing for a distance of about 50 feet and to a depth of 15 feet.

Mack mine.—The Mack mine is on a hillside about a quarter of a mile south of the Victor mine. The pegmatite ledge at this mine is about 12 feet thick, strikes west of north, and dips about 50° E. There are pockets through the whole vein, carrying lepidolite, albite, quartz, tourmaline, garnet, kunzite, etc. There is a gem-bearing streak in the interior which is richer than the remaining portion of the vein. The mine has been worked by stripping off the hanging wall and by open work.

MESA GRANDE.

Himalaya mine.—The Himalaya mine, about 3 miles northwest of Mesa Grande, is a remarkable producer of tourmaline from a small vein. The pegmatite varies from 18 inches to 4 feet in thickness and has been traced several hundred yards. It has a strike of about N. 70° W., and a dip of over 20° SW., and cuts through a hill near the top. This vein has been worked by a large amount of open cut with several drifts on the vein at different levels. Part of the later work has been in a drift 300 feet long on the north side of the hill. The ledge exposed in this tunnel had a marked banded structure, consisting of streaks 3 inches thick with black tourmaline crystals roughly perpendicular to the walls on each side of a pegmatite band 18 inches thick and containing pockets with pink gem and black tourmaline. Crystals of quartz, feldspar, lepidolite, etc., are associated

with the tourmaline. Other recent work consists of a crosscut tunnel on the south side of the hill, in which good ledge material was located. Drifts were to be run in each direction on this part of the vein.

Mesa Grande Consolidated Gold and Gem Mining Company.—The Mesa Grande Consolidated Company is operating a mine one-third of a mile south of the Himalaya mine. The recent work consists of an incline about 100 feet deep with drifts and stopes on the sides. Two shafts were formerly sunk to the northwest with drifts and stopes between them. The pegmatite varies from 6 inches to 3 or 4 feet in thickness and strikes northwest with a southwest dip. Mostly pink tourmaline was being found at the time of the writer's visit. Some of this was first-quality gem material; other was suitable for cabochon cuts.

Esmeralda and Trail mines.—The Esmeralda and Trail mines are about a mile and a half north of west of the Himalaya mine. The Esmeralda mine is evidently on a large pegmatite formation or on several arms of pegmatite. Considerable work has been done in the form of tunnels, cuts, and prospect pits. Biotite and black tourmaline are plentiful in the pegmatite. Beautiful pink and aquamarine beryl and some varicolored tourmaline have beeen found at this mine. At the Trail mine, on the same ridge and just above, the pegmatite carries dark-blue, nearly black tourmaline and much rough muscovite. Beryl crystals are said to have been found here.

Cota mine.—The Cota mine is about one-third of a mile southwest of the Himalaya mine, and the vein consists of a blanket ledge of pegmatite on the hillside. It is from 2 to 5 feet thick and strikes northeasterly with a light southwesterly dip. The ledge is banded with several textures, as seen in one exposure. It contains black, green, and blue tourmaline, with some of slightly pinkish color. Small hyacinth garnets and a pink clay occur in the vein. The gem minerals occur in streaks or long pockets.

Rose Quartz mine.—The Rose Quartz mine, on a narrow, high spur or ridge, is 4 miles N. 60° W. of Mesa Grande. The ledge at this mine is marked by a large outcrop of pale, translucent rose and white quartz. The pegmatite is probably over 35 feet wide and contains quartz segregations 20 feet wide in places. Feldspar also occurs in nearly pure masses 6 to 8 feet through. Large black tourmaline crystals 2 to 5 inches in diameter and several feet long occur in the pegmatite. The only gem mineral so far found has been a very dark reddish hyacinth garnet.

RAMONA.

Little Three and Surprise mines.—The Little Three mine on the northwest and the Surprise mine adjoining on the southeast are situated near the foot and on the south side of a hill, 4 miles N. 70° E. of Ramona, on which a number of gem mines have been located. The pegmatite ledge at these mines has a northwesterly to north of west strike with a dip of 25° SW. The pegmatite varies from 3 to 10 feet in thickness, a portion consisting of finer-grained, banded pegmatite. Some of the gem minerals are found in pockets, while others are frozen in the vein matter. The pockets vary from 1 or 2 feet long and 2 or 3 inches wide to 20 feet long and 12 to 18 inches wide. The gem minerals found are hyacinth garnet, topaz of

white, pale-greenish, bluish, and yellow color, tourmaline, and beryl of white, green, and pink color, associated with clevelandite, orthoclase, muscovite, biotite, and fine quartz crystals. Much very fine specimen material is obtained. The mines are worked by open cuts after the vein has been stripped of overlying rock.

Hercules and Lookout mines.—The Hercules mine is part way up the hillside to the northeast of the Little Three, and the Lookout mine is still farther northeast, extending to the top. The Hercules mine has been worked by a cut and a tunnel 90 feet long. The Lookout mine has been opened at two points by open cuts, one on top of the hill, the other 200 or 300 feet below the top, where the ledge has been stripped through a height of about 75 feet. The Hercules mine contains hyacinth garnet, beryl, tourmaline, and smoky quartz crystals. The Lookout mine has yielded chiefly beautiful hyacinth garnet, though a pocket of green tourmaline has been opened at the top of the hill.

Daggett mine.—The Daggett mine is about half a mile northwest of the Little Three mine. It has been worked as extensively as any of the mines in this district, with several tunnels and a small amount of stoping. The pegmatite is nearly in the form of a blanket ledge on the hillside with a northerly strike and a dip of 35° W. The gems found were pink beryl, green tourmaline, some very dark, and hyacinth garnet, associated with lepidolite, muscovite, biotite, albite, orthoclase, and quartz.

Other mines.—A few hundred yards to the north of west of the Little Three mine are the Reliance and the Mars claims. There are two ledges on the Reliance claim. These ledges were being prospected during 1907 with the result that a little hyacinth garnet, some green tourmaline, and frozen beryl were found. The pegmatite in one of these ledges exhibits a marked banded structure, due to the occurrence of certain minerals, especially tourmaline, in parallel layers. A small amount of hyacinth garnet was found during prospecting work on the Mars claim during 1907.

CUTTING AND SALE OF GEMS.

Several of the companies mining precious stones in southern California have their own lapidary establishments and cut for the local trade and for the markets at a distance. These lapidary establishments are located in Los Angeles, San Diego, and other towns. Some of the cutting shops employ but one or two men, while others keep from five to ten men busy. In San Diego there were at least six of these establishments in operation during 1907, employing from one to six men. Some of these lapidaries work with improved mechanical methods, cutting faceted stones of perfect symmetry and great beauty. Carborundum is principally used for cutting and oxide of tin or chromium for polishing the gems.

The gems bring good prices in the cities of California. Tourmaline of finest quality and facet cut are sold for from $6 to $15, and even as high as $20 per carat, according to size. Flawed tourmaline suitable for cabochon cuts is sold for 50 cents to $1 per carat, according to quality and size. Kunzite is sold for slightly less than tourmaline, though practically the same price is sometimes paid for exceptionally fine, rich, lilac-colored gems. Hyacinth garnet is ordinarily sold for from $3 to $10 per carat, though in some cases higher

prices are obtained. Beryl brings from $2.50 to $15 per carat, according to quality and size. Pink beryl of good quality is sold for about $8 per carat. Considerable turquoise, obtained from Arizona, Nevada, and California, is also cut and sold by the lapidaries. The one-color blue gems bring from $3 to $10 per carat and matrix stones from 25 cents to $1 or more.

THE GEMS OF NORTH CAROLINA.

An admirable treatise on the "History of the gems found in North Carolina," by Dr. George F. Kunz, has recently appeared as Bulletin No. 12 of the North Carolina Geological and Economic Survey. The report is illustrated with fifteen plates showing specimens of gems, their associated minerals, and occurrence. Four of the plates are beautifully colored, showing either rough or cut gems, or both, of ruby, sapphire, diamond, beryl, aquamarine, emerald, hiddenite, smoky and rutilated quartz, amethyst, cyanite, and rhodolite garnet. Doctor Kunz calls attention to the fact that many of the gems of North Carolina have been found or obtained during mining for other minerals, as corundum, mica, monazite, etc. The history of events leading to the discovery of certain gems, as the emerald and emerald matrix on Crabtree Mountain, Mitchell County, and the emerald and hiddenite deposits of Alexander County, is given. The occurrence of ten authentic finds of diamonds and several reported discoveries are carefully reviewed. The corundum gems, or ruby and sapphire, beryl gems, or aquamarine and emerald, hiddenite, quartz gems, as amethyst, rock crystal, smoky, rutilated quartz, etc., and garnet, receive the most attention. Other gems, as moonstone, rutile, cyanite, etc., are mentioned. The coloring of the different gems is well described.

GEM MINERALS OF CANADA.

A few notes on the gem minerals of Canada have been kindly furnished by the director of the geological survey of Canada, through Mr. R. A. A. Johnston, a mineralogist of that survey. The following minerals have been found as recorded:

Beautiful pinkish colored and clear white apophylite in the mines of Rossland, British Columbia.

Pale to dark blue colored amblygonite in small masses near Lake Ramsay, Lunenburg County, Nova Scotia.

Aventurene, composed of amazon stone interlaminated with quartz, on lot 7, concession A, Cameron Township, Nipissing district, Ontario.

Large crystal masses of translucent and clear sea-green colored fluorite in a vein near the village of Madoc, Hastings County, Ontario.

Fine green scales of fuchsite scattered through dolomites and magnesites in Yukon district. Polished specimens form handsome ornamental stone with greenish and reddish mottling in a groundmass of white or yellowish white.

Dark wine or cherry-red almandine garnets in large crystals in a hornblende schist south of Hudson Strait, Ungava district. Almandine suitable for gems is occasionally found in Chicoutimi and Charlevoix counties, Quebec.

Agate and chalcedony in many places in the volcanic rocks of Yale and Caribou districts, British Columbia. Small masses of prase

at the head of Nicoamen River, Yale district, British Columbia. Morion quartz, in some cases an inch or two thick, in the vicinity of Lake Ramsay, Lunenburg County, Nova Scotia.

Vesuvianite, of a honey-yellow color, of fine gem quality, in the township of Harrington, Argenteuil County, Quebec.

Mr. H. S. Williams, of New York, reports a production of sodalite in British Columbia, from which locality 125 pounds were obtained by himself and Mr. O. M. Harper.

GEM MINERALS OF MADAGASCAR.

A report on the precious stones of Madagascar has been prepared by Albert Dabren,[a] mining engineer of the colony. The following is quoted from the abstract of this report by W. T. Schaller:[b]

In pegmatites traversing crystalline schists are found the following gem minerals: Amethyst, zircon, sapphire, topaz, garnet, tourmaline, and beryl, the last two being mined as gems. The variously colored tourmalines—pink, green, blue, and colorless—are found in the pegmatites, which consist of quartz, mica, orthoclase, microcline (sometimes green), and albite. The associated minerals are lepidolite, garnet, yellowish green and pink spodumene, and pink, yellow, green, and pale-blue beryl. In some crystalline limestones are found green spinel, reddish, bluish, and greenish corundum, white diopside, and tremolite. In the important river alluviums occur corundum, spinel, yellow transparent chrysoberyl, topaz, beryl, almandine garnet, tourmaline, and quartz. Colored corundum is very abundant in certain alluvium deposits, being found here with the other gems above mentioned. These corundums have not as yet been found in place. They seldom yield cut gems of over a carat weight. Abrasive corundum is also found. Greenish blue kyanite is found in place in mica schist. Colorless, yellow, brown, or pink zircons, not found in place, are very abundant in the alluviums. They are too minute to be used in jewelry. In 1906 the exportation of precious stones amounted to 29,716 grams, of which 7,930 grams were tourmaline, 1,350 beryl, 1,135 garnet, and 1,000 rose quartz. The production of rough corundum from Analambato was 243,280 grams. The modes of occurrence, association, and especially the localities for the various minerals named above are described very fully in the paper.

RADIUM AND CORUNDUM.

The experiments performed by Mr. F. Bordas on the action of radium on sapphire gems are of interest.[c] It was found that blue sapphire, exposed to radium bromide of 1,800,000 activity, changed to green, to yellow, and finally to dark yellow; while red sapphire changed to violet, to blue-green, to yellow. Mr. Bordas observes that the color is not destroyed by heat, though Mr. George B. Selden, jr., of Rochester, N. Y., in repeating these experiments[d] found that the yellow color was quickly destroyed by heating the sapphire to 800°. It is not thought these reactions will be commercially used, though they are scientifically interesting.

PRODUCTION.

The production of precious stones in the United States during 1907 as reported to the Survey was much greater than during 1906. The values given in some cases are those estimated for an output of a known quantity of gems, and where possible the value of the rough material is represented, in accordance with the aim of the Survey. It is often impossible to obtain accurate figures in this form, since it

[a] The precious stones of Madagascar: Bull. économique, 4e trimestre, 1906. (Tananariva, Madagascar.)
[b] Chem. Abstracts, vol. 2, No. 7, Apr. 10, 1908.
[c] Mining Jour., London, November 9, 1907, and April 4, 1908
[d] Jewelers' Circ. Weekly, February 12, 1908.

can not be known what a certain lot of rough mineral will yield when selected and cut. Some of the figures of production furnished this office are evidently the values for elaborated gems, while others may represent but little more than the cost of mining. Aside from the difficulty experienced in obtaining figures from certain producers, there is a considerable production of various gems from scattered localities concerning which little information can be obtained.

The table shows an increased production of several minerals during 1907 over 1906. The most important increase is in the production of sapphire, which was mined in unusually large quantities in Montana. A substantial increase is recorded in the production of tourmaline and chrysoprase, and in several minerals produced in small quantities, as amazon stone, rose quartz, topaz, and utahlite and amatrice. A substantial production of californite was reported for 1907; no output was recorded for 1906. Several other gems are listed with a production in 1907 for which no record was obtained during 1906, as gold quartz, jasper, pyrite, smithsonite, etc. One new gem mineral from California, benitoite, was added to the list. Values of the production of such minerals as diamond in Arkansas, emerald and ruby in North Carolina, were estimated from outputs reported or seen.

Production of precious stones in the United States in 1906 and 1907.

Precious stone.	Value.		Remarks.
	1906.	1907.	
Agate, moss agate, etc	$800	$650	6,000 pounds; Colorado and Washington.
Amazon stone	100	1,025	2,300 pounds; principally from Colorado.
Amethyst	700	850	Chiefly from Virginia and North Carolina.
Azurmalachite	.....	250	Arizona and Nevada.
Benitoite	.....	1,500	Rough gem stock; California.
Beryl: Aquamarine, blue, pink, etc.	9,000	6,435	California, North Carolina, Colorado, Maine, Pennsylvania, and New Hampshire.
Californite	.....	[a] 25,000	5,000 pounds; California. Called jade.
Catlinite	.....	25	Pennsylvania.
Chiastolite	25	20	Massachusetts.
Chrysocolla	.....	150	Arizona and New Mexico.
Chrysoprase	[a] 32,470	[a] 46,500	3,105 pounds; green and blue.
Cyanite	.....	100	North Carolina and Pennsylvania.
Diamond	.....	[a] 2,800	About 200 carats, from Arkansas.
Diopside	5	.....	
Emerald	.....	[a] 1,320	North Carolina.
Epidote	.....	60	Colorado and Pennsylvania.
Feldspar, moonstone, etc	.....	85	Pennsylvania and North Carolina.
Garnet: Hyacinth, pyrope, almandine and rhodolite.	3,000	6,460	California, Colorado, Arizona and New Mexico, South Dakota, and North Carolina.
Gold quartz	.....	1,000	Nevada.
Jasper	.....	675	4,250 pounds; California and Colorado.
Opal	.....	180	Oregon, California, and Colorado.
Peridot	2,400	1,300	Arizona and New Mexico.
Petrified wood	150	325	6,000 pounds; Colorado and Arizona.
Phenacite	250	25	Maine.
Prase	50	.....	
Pyrite	.....	400	Colorado.
Quartz: Rock crystal, smoky, rutilated, etc.	3,050	2,580	Several thousand pounds from various States.
Rose quartz	4,000	6,375	51,300 pounds; South Dakota and Colorado.
Rhodocrosite	.....	150	1,000 pounds; Colorado.
Ruby	600	2,000	North Carolina.
Rutile	.....	200	North Carolina.
Sapphire	39,100	[a] 229,800	About 11,000,000 carats; Montana.
Smithsonite	.....	800	200 pounds for cutting; many specimens.
Spodumene, kunzite, and hiddenite.	14,000	14,500	About 126 pounds; California and North Carolina.
Topaz	1,550	2,300	Utah, California, Texas, and Maine.
Tourmaline	[a] 72,500	[a] 84,120	2,140 pounds; California, Colorado, Maine, and Connecticut.
Turquoise	22,250	[a] 23,840	Arizona, Nevada, New Mexico, and California.
Variscite, amatrice, and utahlite	2,000	7,500	Utah.
Total	208,000	471,300	

[a] Estimated.

IMPORTS.

The importation of precious stones into the United States in 1907, as reported by the Bureau of Statistics, showed a large decrease from that of 1906. The greatest ratio of decrease was in the imports of pearls, which was nearly 72 per cent less than in 1906. The imports of uncut diamonds decreased nearly 29 per cent, and of cut, unmounted diamonds over 25 per cent. There was a marked decrease in the imports of other precious stones, though imports of glaziers's diamonds and diamond dust or bort were both greater in 1907 than in 1906. The decrease was largely due to the panic of the last part of 1907, at which time the imports fell off heavily. The precious-stone industry during the first part of 1908 has been greatly depressed, though it is slowly recovering, as shown by the monthly imports.[a] In February the imports amounted to $200,443; in March to $389,514; in April to over $400,000, and in May to $463,454. These figures are far below those for 1906.

The following table shows the value of the diamonds and other precious stones imported into the United States from 1903 to 1907, inclusive:

Diamonds and other precious stones imported and entered for consumption in the United States, 1903–1907.

Year.	Diamonds.					Diamonds and other stones not set.	Pearls.	Total.
	Glaziers'.	Dust or bort.	Rough or uncut.	Set.	Unset.			
1903	$10,634	$720,150	$10,275,800	$675	$13,022,367	$2,494,897	$2,414,524	$28,939,047
1904	73,054	445,621	10,234,587	559	13,439,023	1,893,969	1,142,150	27,228,963
1905	6,851	190,072	10,281,111	741	20,375,304	4,144,434	1,847,006	36,845,519
1906	104,407	150,872	11,676,529	305	25,268,917	3,995,865	2,405,581	43,602,476
1907	410,524	199,919	8,311,912	.....	18,898,336	3,365,902	680,006	31,866,599

PEARLS.

UNITED STATES.

It was not possible to obtain a statement of the production of pearls in the United States, since a complete list of producers could not be obtained. There was, however, a considerable production of pearls and pearl-button shells in the Mississippi Valley region, and an estimate by Mr. Frank Koeckeritz, a large dealer in that region, is given. Mr. Koeckeritz estimates the production of pearls and slugs in 1907 at $264,500, as against $381,000 in 1906. The values given represent the first values at the point of finding the pearls before they have passed through the hands of dealers, jobbers, and retailers. The quality and prices remained about the same as during 1906, when white, cream, pink, purple, blue, and, rarely, black pearls of irregular, button, round, oval, pear, and drop shapes were found. The prices range from $1 to $2,000 each, and from $1.50 to $60 an ounce for slugs.

Mr. Koeckeritz estimates that 35,000 short tons of button shells were produced and sold during 1907 in the Mississippi region. The average price paid for these at the point of production was about $11 per ton, or $385,000, and about $586,250 at the button factories.

[a] Jewelers' Circ. Weekly, June 19, 1908.

About 3,000 tons of "washboard" shells, hitherto not purchased by the button factories, were bought at about $5 per ton along the Illinois River, where their quality was found to be better than usual.

The exports of pearl shells to Europe were less in 1907 than 1906, since the domestic manufacturers paid better prices for them. The decrease in production was due to high waters during part of the season, a general late season in the spring of 1907, and to the cessation of the buying of shells at the beginning of the panic in the fall.

The National Association of Pearl Button Manufacturers place the production of pearl shells during 1906 at 48,000 tons, valued at $737,280.[a] A total of 25,200,000 gross of pearl buttons were turned out during 1906 by factories in 17 different States.

The United States Fish Commission has been engaged in an investigation of the habits and life of the mussel clam. It is hoped that the information collected on this subject will lead to passage of laws to protect the mussel clams and to aid in their artificial propagation. At the present rate of destruction of the mussels and of waste of pearl shells, it will be but a few years before the mussels will be practically exterminated.

Mr. Frank Koeckeritz states that the pearl fisheries were very scattered in 1907. In the early part of the season the Wabash River was worked by a large number of fishers. The Illinois River soon became prominent, however, and attracted crowds of mussel diggers. There was greater activity along the Mississippi River, the White and the Black rivers in Arkansas, and the Cumberland River, than for some years.

There was some pearl fishing in many other rivers in different parts of the United States. Mr. Alfred Scholten reports a small output from the Colorado River between Blufton and Tow, Tex.

Several large pearls, valued at between $1,000 and $2,000, were reported during 1907. One of these was found near New Albany, Ind., in the Ohio River, and was one-half an inch in diameter.[b] It was slightly flattened on one side and perfectly oval on the other. Another pear-shaped pearl, weighing about 87 grains, was found near Williamsport, Ind.[c] The owners expected to realize $2,000 for it. A very large pearl, weighing 165½ grains, was found near Dubuque, Iowa. It has been valued at between $2,000 and $6,000.

MEXICO.

According to Consul W. D. Shaughnessy, of Aguascalientes, a Mexican company is successfully cultivating pearls in the Gulf of Lower California.[d] It is said a man named Vives discovered that the pearl developed in about two years' time, when the shell dropped it out. Accordingly, the shellfish are protected from the time they are hatched and opened when nearly two years old before the pearl has been lost.

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[a] A few notes upon the pearl button industry of America: Nat. Assoc. Pearl Button Manufacturers U. S. of America.
[b] Manuf. Jeweler, September 5, 1907.
[c] Manuf. Jeweler, August 1, 1907.
[d] Daily Cons. Repts., March 30, 1908.