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WALTER RENTON INGALLS

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GEMS AND PRECIOUS STONES.

THE only gem minerals produced with any regularity in the United States are beryl, garnet, peridot, ruby, sapphire, spodumene, tourmaline and turquoise; and of the States, California, Montana and North Carolina show the most activity. The following details of gem mining in the United States are taken mainly from the works of George F. Kunz, of New York, published by the California State Mining Bureau, and in the "Mineral Resources of the United States," and from those of Joseph Hyde Pratt, published by the North Carolina and the United States Geological Surveys.

BERYL.

California.[1]—The Mack mine, near Rincon, San Diego county, has yielded a quantity of fine gem beryl, and also a deep blue variety of the mineral. The beryl occurs in a 5 ft. pegmatite vein between granite and diorite. The best crystals are found in soft, clayey pockets. Another promising locality lies four miles northeast of Ramona. Here the beryls are found as solitary crystals in pockets scattered through the decomposed feldspathic central zone of a pegmatite vein. The stones are a brilliant rose pink and quite notably flawless. One perfect gem, weighing 30 carats, has been cut. Near the Mexican border, around Jacumba Hot Springs, numerous openings have shown beryl associated with garnet, in payable quantities; the region, however, is not easily accessible and is devoid of both fuel and water.

New Hampshire.—An old locality at Springfield, Sullivan county, has recently afforded some beryls of gem quality. A parallel vein, only 25 ft. distant, was formerly worked for mica.

North Carolina.[2]—Extensive mining for beryl has taken place in the vicinity of Hiddenite, Alexander county, since 1881. The beryls occur with finely crystallized quartz and rutile in the pockets of quartz veins, which cut gneisses. The productive veins all have a uniform strike nearly east and west, and dip to the north; other irregular veins show no pockets. The largest beryl ever found here was a doubly terminated crystal, of light-green color, weighing 8¾ oz. Small beryls, of deep green color, have been mined in a pegmatite vein on Crabtree mountain, Mitchell county. Fine beryls, of the aquamarine variety, are commonly found in the pegmatite veins of North Carolina, that have been worked for

[1] "Mineral Resources," 1904, p. 977 *et seq.*

[2] Joseph H. Pratt, "The Mining Industry of North Carolina during 1904."

mica. The Wiseman mine, near Spruce Pine, Mitchell county, operated by the American Gem and Pearl Company, of New York, is the largest producer. Its stones include aquamarine, the yellow and the blue varieties of beryl, in pieces such as would cut gems of about 10 carats.

Utah.—An unusual variety of beryl has been found in the Dugway range, 35 miles southwest from Simpson Springs. The crystals have a rich raspberry red color, due probably to the appreciable amount of manganese that they contain. They are tabular prisms, 3 mm. high and 7 mm. across.

GARNET.

The mining of garnet for use as an abrasive has been described on a previous page. Of the several gem varieties of garnet, the only ones in regular supply in the United States are essonite (pale yellow), pyrope (deep transparent red), rhodolite (brilliant rose), and spessartite (purple). The common abrasive garnet is mainly of the alamandite variety.

In southern California essonite and spessartite are found in significant amounts in pegmatite veins. The Surprise and the Hercules mines, 4½ miles northeast of Ramona, are the most developed prospects, while the region around Jacumba Hot Springs is no less well supplied with garnets. The Hercules mine has yielded spessartite in flawless stones weighing from 1 to 6 or 8 carats, and selling at $20 per carat. The natural conditions at this locality are less forbidding than at many others in southern California.

North Carolina has supplied gem pyrope from the gold placer workings of Burke, McDowell and Alexander counties. In Macon county the streams heading on Masons mountain have yielded beautiful rhodolites, some of which have been cut into gems of as high as 13 carats each. The rose tint of this stone is most striking in artificial and by reflected light. This is a comparatively new species, originally identified from this locality and contains nearly equal proportions of iron and magnesium oxides, besides the usual alumina and silica. The productive workings are owned by the American Gem Mining Syndicate of St. Louis.

PERIDOT.

The most recently discovered, as well as the most productive source of this mineral (common enough in non-gem quality in basic magnesian igneous rocks) is in Gila county, Arizona, near Talklai. The crystals occur in their native matrix, a lava, from which the weathering of its vesicular portions, frees the more resistant crystals. A single stone 1½ in. long and weighing 1½ oz. has been recorded. Numerous gems, weighing from 1 to 5 carats, have been cut from these crystals.

RUBY.

Montana.—Corundum gems of the true ruby color have been found in

association with sapphires in southern Granite county, near the headwaters of Rock (or Stony) creek. Sapphires, colorless, and also of pale-green, yellow pink, and bluish colors, constitute much the larger part of the gem wealth in this and other parts of Montana, and will be referred to under the next heading.

North Carolina.—Rubies of fair color have been found in the Corundum Hill mine, referred to on a previous page. The most favored locality for rubies, however, lies around Cowee creek, Macon county, six miles north of Franklin. Here the American Prospecting and Mining Company of New York has been working, on its 5000 acres, since 1895. The rubies are contained in gravel beds, overlain by 2 ft. of soil, and these are worked by ordinary hydraulic methods with sluices, sieves and rockers. No basic magnesian rocks, such as enclose the main corundum deposits of North Carolina, are found in the vicinity of Cowee creek, nor any limestone, although in every other respect the ruby deposits resemble closely those of Burma. The country rock is a fine grained gneiss, mainly highly decomposed; no rubies have been found in the unaltered rock. Many of the Cowee rubies contain minute inclusions which give a cloudy appearance to the polished gem. Some cut stones have weighed 3 or 4 carats and many of the smaller ones are perfectly transparent, though injured by cracks. In color and brilliancy the Cowee rubies rival those of Burma, but the output shows a rather smaller proportion of flawless stones. They show a marked pleochroism, being deep red, of the true pigeon-blood tone, when viewed along the crystallographic axis, but pale pink when seen from the side. The two most common crystal habits of these rubies are a tabular rhombohedron and a hexagonal prism.

Other localities at which rubies of gem value have been found in North Carolina are the Mincey mine on Ellijay creek, Macon county, and at a point near Montvale, Jackson county.

Sapphire.

Montana.—This is the only State to show organized sapphire mining; the output comes from three distinct localities: (1) Along a 12-mile stretch of the upper Missouri river, 15 miles northeast of Helena; (2) on Rock creek in southern Granite county, 30 miles west of Anaconda; (3) at Yogo gulch, in Fergus county, 75 miles northeast of Helena.

1. Sapphires are found in the gravel banks along the headwaters of the Missouri; the most active mining has been at the two bars named Spokane and Eldorado. The gravel beds vary from 10 to 50 ft. thick and rest upon slate, rising to 50 ft. above the river. They have been worked in turn by English and American companies, but with no financial success, owing partly to over-capitalization but particularly to the less esteemed colors of the stones. These are generally of pale-green or

greenish-yellow colors, while the prized red or blue stones are rare. For this reason, it is doubtful if the sapphires in the remaining gravel will ever pay the expense of recovering them. The crystals in this locality hold uniformly to a prismatic habit.

2. Sapphires are found in a limited area among the tributaries of Rock creek. Of the total output of 400,000 carats of rough stones recovered in the active period of 1899–1900, only 25,000 carats were fit for cutting. These stones show a wider range of colors than those from the first locality, greenish-blue being the prevailing color, not, however, approaching the prized deep-blue color of the Oriental stones. Many beautiful yellow sapphires, one of them having been cut to a 2-carat gem, are found here, as are also pink ones.

3. The Yogo gulch locality is the most widely known. Here the alluvial deposits have been exhausted, and mining is now directed to the two parallel dikes that formed the original matrix of the sapphires. These are 800 ft. apart, in limestone, and are a dark basic rock consisting mainly of biotite and pyroxene, and related to the minettes and shonkinite of the region, having, however, no feldspar. Mining is accomplished by shafts and open cuts. The upper portions of the dikes are thoroughly decomposed, rendering a simple hydraulic treatment possible. The more solid rock in depth has to remain exposed to the decomposition of the atmosphere for a season, before it can be thus treated. It is economically impossible to extract the small yield of sapphires from the fresh rock. The prevailing color of the stones is a bright blue, but a few show the dark blue of the Ceylon sapphire. In richness and brilliancy, however, they excel the Oriental stones, and are equally brilliant whether in natural or artificial, transmitted or reflected light. They differ from the prismatic crystals of the first two mentioned localities, in that they adhere uniformly to the rhombohedral habit. The largest stones found here weighed 11 to 12 carats in the rough, and 5 to 6 carats when cut. One stone of 4 carats was valued at over $75 per carat. The two operating companies at this locality are the New Sapphire Mines Syndicate and the American Gem Company. Their entire output is shipped to London. The first mentioned company has an annual output of 100,000 carats, and the second employs regularly a force of 15 men, at Helena, for cutting the gems.

North Carolina.—Small sapphires of nearly all representative colors have been found in the Corundum Hill mine, previously referred to. The part of the mine in which the gem stones are most abundant has not been worked for 14 years, but stones can be obtained by washing the alluvial gravel below the mine. This is the only locality in the United States that has yielded the emerald-green sapphire, the true Oriental emerald, and here it is rare, the yellowish and light-green varieties being

more common. What is probably the finest true emerald in the world, a crystal 4x2x1¼ in., part of it transparent, came from this mine.

Spodumene.

The usual appearance of this lithium-aluminum silicate is a massive, opaque dull white crystal, worthless as a gem; its opacity appears to have resulted from chemical alteration, a core of transparent mineral often being found at the center of a large crystal. It is found at several points in New England and at the Etta tin mine of South Dakota, where it is mined and shipped for the manufacture of lithia. Near Pala, San Diego county, Cal., spodumene is found in unaltered, transparent, and flawless crystals of a pink or lilac color; this variety has been named kunzite. The spodumenes are found in pegmatite veins, in which the quartz crystals reach an immense size; the muscovite is often replaced by lithia mica, and colored tourmalines appear in place of the usual black ones. The feldspar is decomposed, in layers, and in these the kunzites are found, singly or in pairs, embedded in the clay filling of small cavities. The presence of manganese minerals in the vein suggests manganese as the coloring agent of the kunzite.

The natural crystals range in weight up to 31 oz. troy as the maximum, and are etched and corroded on their surfaces. Pleochroism, colorless to lavender, is marked. They are readily cut into exceedingly brilliant gems of from 1 to 150 carats, selling for about $6 per carat. Their characteristic tints, pink and lavender, are among the rarest colors known in gem stones. From the scientific aspect, kunzite is particularly interesting for its behavior under the influence of ultra-violet light waves, X-rays, or radium emanations. Subjected to any one of these, kunzite shows marked phosphorescence, which, in the case of X-rays, endures for several minutes after the excitation has ceased, and with sufficient strength to produce an autophotograph on a sensitive plate.

Another gem variety of spodumene is hiddenite, in bright green transparent crystals, found at Stony Point, Alexander county, N. C. The mine has not been worked for several years.

Tourmaline.

California.—Gem tourmalines have in late years been found abundantly in southern California, always in association with the numerous lithia-bearing pegmatite veins. The output comes from three general districts: The Mesa Grande and the Pala regions of San Diego county, and the Coahuila region of Riverside county. The companies now actively productive are: Fano Kunzite-Tourmaline Mining Company, Hemet, Riverside county; Pala Chief mine, Pala, San Diego county; Tourmaline Queen mine, Pala; Himalaya Mining Company, Mesa Grande, San Diego county; San Diego Tourmaline Mining Company, San Diego.

The last mentioned is engaged in systematic mining near Mesa Grande, and operates its own lapidary in San Diego. Numerous other prospects are in progress of development, and although this district is handicapped by lack of fuel and water, the variety and quality of the tourmalines will give its development a strong impetus. The stones range from pink and bright red to deep blue and a peculiar greenish-blue; a stone of the latter sort, when cut, will show sapphire blue in one set of facets, and emerald green in another set.

Connecticut.—The old tourmaline mine at Haddam Neck, on the east bank of the Connecticut river, has lately shown a renewed activity. Here a vertical dike of nearly pure albite, over 50 ft. wide and of unknown depth, has been quarried for many years to supply white feldspar for the pottery and the polisher industries. In a zone 3 ft. wide on the eastern flank of the dike, where the albite is somewhat mixed with quartz, muscovite, lithia mica, garnets, etc., beautifully colored tourmalines are found. These are chiefly green, but others are pink or red, and some show different colors in the same crystal. Many fine stones have been cut, but the majority of the specimens have been collected in museums.

Maine.—Gem tourmalines are mined at Rumford Falls, Oxford county, in a 5 ft. pegmatite vein containing other lithia minerals. Their colors include green, red and dark blue, besides the colorless achroite. The stones are fine and clear and one of them has yielded a gem of 16 carats.

Turquoise.

The commercial supply of turquoise comes from New Mexico, where it is mined in the Cerrillos hills, in the Burro mountains, at Old Hachita, and in the Jarilla mountains. The turquoise at the first locality has been worked from antiquity. The mineral has been found in southern Colorado, and, in small quantity, in New Jersey, at the copper mines of Somerville.

Diamond.

Diamonds are brought to light from time to time in various parts of this country, in the glacial drift. Two companies are now engaged in mining for diamonds in California. One of them will work at White Rock hill, two miles northeast of Placerville, El Dorado county, where some stones have been found in times past. The other will work at Cherokee, Butte county. In the last 20 years over 60 diamonds have been found in the Cherokee mine, the most valuable one having been rated at $1200, but most of them ran in value from $20 to $100. Most of the stones are of a light-yellow tinge, although a few pure white ones have been found.

The similarity of some of the dike rocks of New York State to the diamondiferous rocks of South Africa has stimulated investigation as to their

possibilities. Daniel S. Martin has recently examined some of the most prominent dike rocks in New York[1]; he found that while the material composing them is practically identical with that in the South African peridotites, yet in New York the diamond is lacking. The only gems hitherto known to accompany the New York peridotites are pyrope, olivine, and topaz. It has been reported that diamonds have been found in the drift south of Syracuse, N. Y. The owner of a sand bed near that city claims to have found a good-sized diamond which he sold for $250. Topaz occurs in the drift, and it is believed the gem above referred to was an exceptionally brilliant topaz. It may be said, however, that the formation at Syracuse is likely to be diamondiferous, and it is possible that systematic prospecting operations would result in the discovery of diamonds.

An area in Elliott county, eastern Kentucky, on Little Sandy river, 30 miles east of Owingsville, has been examined with some care; the prevailing rock is said to be identical with that on the South African fields, and a few good stones have been found.

Diamond Mining in Foreign Countries.

For a number of years the diamond industry has practically been confined to, or at least dominated by, South Africa. The progress of diamond mining there is, therefore, a measure of the world's progress.

South Africa.

Orange River Colony.—The report of the DeBeers Consolidated Mines, Ltd., for the year ending June 30, 1905, shows a profit, somewhat smaller than that of the previous year, attributable both to a heavier outlay for mining, and to a slightly diminished yield of diamonds from the dirt of the largest mine. Details of the year's work at the company's five mines may be tabulated thus:

Mine.	Output of blue ground for year.	Yield per load.	Value per carat.	Value per load.	Cost per Load.		
					Mining. (b)	Washing.	Total.
	Loads. (a)	*Carat.*					
DeBeers	2,447,850	0.46	$12.68	$5.81	$1.17	$0.62	$1.79
Kimberley					1.29	0.71	2.00
Wesselton	2,068,278	0.284	8.86	2.52	0.61	0.31	0.92
Bultfontein	605,730	0.41	8.38	3.43	0.98	0.44	1.42
Dutoitspan	311,499	0.26	16.73	4.37	1.91	1.04	2.95

(a) The "load" occupies 16 cu. ft. and weighs about 1600 lb. (b) Including the cost of handling waste rock.

The total output of the mines during the year was 5,433,357 loads, of which 5,128,015 were washed; the stock of blue ground on the washing floors was thereby increased from 3,944,397 loads at the beginning to 4,249,739 loads at the end of the year.

The DeBeers mine has two shafts, respectively 2076 and 1670 ft. deep. Rock proved above the 1670-ft. level amounts to 2,560,900 loads; between

[1] "Peridotite Dikes of New York," Onondaga Academy of Science, New York, Oct. 24, 1905.

this and the 2076-ft. level the reserves are estimated at 3,376,300 loads.

Kimberley mine has 892,300 loads above the 2200-ft. level; reserves are estimated at 1,196,900 loads between this and the 2520-ft. level.

Wesselton mine is 500 ft. deep, and has 12,915,800 loads above this level. Inclined haulage has been abandoned; all the dirt is now dropped into the 500-ft. level and hoisted through the shaft.

Bultfontein mine is 600 ft. deep, and has a reserve of 13,866,000 loads above this level. Hoisting from the open mine has been stopped.

Dutoitspan mine is 750 ft. deep; its reserve above this level is estimated at 24,518,500 loads.

The year's work, after allowing liberally for redemption and depreciation, yielded a net income of £1,949,099, out of which £1,800,000 was distributed to holders of both common and preferred stock, at the rate of 40 per cent. each.

The Transvaal.—The report of the Premier Diamond Mining Company for the year ending Oct. 31, 1905, shows, as compared with the previous year, an enlarged output of stones, increased working and general expenses, and a diminished yield of diamonds per load of material mined. The company mined 2,036,782, and washed 1,388,071 loads, an increase of about 50 per cent. over 1904. The output was 845,652 carats, valued at £994,687, as compared with 749,635 carats, worth £866,030, in 1904. The average yield per load fell from 0.798 carat in 1904 to 0.609 carat in 1905, due to the unavoidable inclusion of a low-grade reef in the working face of No. 1 mine; much of the material washed during 1905, furthermore, came from a cut made to connect Nos. 1 and 2 workings, most of which was in barren material. Mining costs per load rose from $0.632 to $0.674 in the latter year, influenced by deeper working and a larger amount of development, charged to mining. The net profit for the year was £622,634, or £45,104 less than the profit earned in 1904, the decrease being accounted for by disproportionately augmented charges for office management and directors' fees. Dividends amounting to £260,000 were distributed from the earnings of 1905. The enormous Cullinan diamond which weighs 3 024¾ carats, discovered in the Premier mine in January, 1905, has not yet been disposed of, but is kept in stock at a nominal value of £3 290, which low valuation, in itself, creates a strong reserve.

The big diamond is a portion of a much larger stone, the original form of which can only be roughly guessed at. Four pieces of this original stone have been broken off along cleavage planes, which have the position of octahedral planes. Each of these fragments must have been of considerable size. Consequently the stone itself shows only a portion of its original natural surface (called "nyf" in the diamond-cutters' jargon), the greater portion being formed by these four flat cleavage planes. The remaining part of the surface shows one octahedral face and a curved irregular surface

roughly corresponding to six faces of the dodecahedron, while one very irregular face of the hexahedron is indicated by quadrilateral impressions which are characteristic of these faces in minerals, such as the diamond, which possesses the octahedral mode of growth.

The stone is a single crystal, no twinning planes or twinning lamellæ being present. It is quite colorless, its perfect transparency being best compared to that of pure ice or of the variety of silica known as hyalite. There are a few grains (inclusions), and also some flaws, or internal cleavage planes—"glessen," as the diamond-cutters call them—in it, but their position is such that they do not detract from the value of the stone as a gem. It is certainly the purest of all the very big stones known.

This great diamond has now reached London; previous to shipment it was insured at $1,250,000. It weighs 3024¾ carats or 1.7 lb. troy; the largest stone previously found in the same mine weighed 392 carats only. Its dimensions are roughly 4 in. x 2½ in. x 1¼ in. Until this find was made, the biggest South African diamond was the Jagersfontein stone, which weighed 971¾ carats.

South America.

Brazil.—The export of diamonds from Brazil is undergoing a steady decline, having had a value of $315,360 in 1902, $247,042 in 1903, and $139,205 in 1904.

The diamond fields are in Bahia, and their geology has recently been described by Orville Derby in the September, 1905, *Boletim* published by the Secretary of Agriculture, for the State of Bahia. An American company is preparing to work the alluvial deposits for gold and diamonds, with dredges and other improved means.

British Guiana.—Exports of diamonds from British Guiana in 1905 amounted to 5288 carats, valued at $30,658, as compared with 11,046 carats, worth $85,947, in 1904. The stones are small, averaging, in 1905, only 0.06 carat per stone, and of a value of $5.80 per carat.

The Diamond Market.

The prices of diamonds have followed, within recent years, a steeply ascending path, in the fixing of which the two South African companies are instrumental. Three advances of 5 per cent. each occurred in 1905 and four in 1904, reaching a total of 60 per cent. increase in the London price of uncut diamonds within four years. The purchasers of rough diamonds were furthermore required to accept arbitrarily constituted lots, containing certain proportions of inferior stones, or of large stones, which do not cut to the best advantage.

The circumstances alleged by the London agencies in justification of the advances are shortages in those varieties of stones most in demand, higher

mining expenses, and the double taxation of the industry, which is levied upon both in South Africa and in England. A more probable reason is that the two formerly rival producers now see the advantage of harmony, and are together profiting by the present heavy demand for diamonds, a feature that has always been characteristic of an era of business prosperity.

The Elmore Process for Diamond Recovery.

The extraction of diamonds from the decomposed rock in which they occur in South Africa has been for a long time effected by greased tables, to which the diamonds adhere, while all other minerals are washed off. When the grease, which is of a particular kind, is removed and melted, the diamonds sink to the bottom of the pot. The process is of high efficiency, tests having showed that only 0.25 to 1.68 per cent. of the diamonds, by weight, passed off in the tailing from the table. The separation is effected by means of the property of adhesion. The Elmore process of oil concentration also operates by virtue of that property of certain minerals with respect to oil.

The experiments have resulted very successfully, practically 100 per cent. of the diamonds being recovered, and the process has now been adopted by the Premier diamond mine, which intends to erect immediately a plant capable of treating 800 tons of blue ground per day. The company is at present treating 1500 tons per day by the pulsators and grease boards.

It is thought that the Elmore process will materially reduce the cost of treatment, afford a higher extraction of the gems, and lessen the losses by theft.