DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, DIRECTOR

MINERAL RESOURCES

OF THE

UNITED STATES

CALENDAR YEAR

1911

PART II—NONMETALS

WASHINGTON

GOVERNMENT PRINTING OFFICE

1912

GEMS AND PRECIOUS STONES.

By Douglas B. Sterrett.

INTRODUCTION.

An important feature of the gem-mining industry in the United States during 1911 was the result of prospecting at the Turner emerald mine near Shelby, N. C. The quality of some of the gems and the value of all gem material found in this deposit with a limited amount of development work are promising. Gems valued at $100 to $200 per carat have been obtained, and the quality of the average run of the emeralds probably equals that of South American emeralds. The mine has been purchased by New York men, who expect to test it thoroughly.

Much interest has been displayed in chalcedony and quartz gems, such as agates, moss agate, jasper, and bloodstone, resulting in an increased output. Moss agates of very fine quality and a few gems showing quite remarkable landscapes were cut in Montana. Discoveries of new deposits of bloodstone and of a beautiful variety of chalcedony, resembling St. Stephen stone, in California have proved of interest. Beach-pebble gems were polished along the coast of California and Oregon as usual, and furnished many attractive souvenir gems for tourists. Renewed activity in sapphire mining in Montana resulted in a large output. The mines of the Yogo American Sapphire Co. and of the New Mine Sapphire Syndicate in Fergus County produced many stones of a fine blue color, and the placer deposits of Granite County, Deerlodge County, and along Missouri River contributed a large quantity of varicolored stones for gems and mechanical purposes.

Opaque blue and green gems, such as turquoise, variscite, and copper-ore gems, were used in some quantity, but the production was much smaller than during the preceding two years. Much of the material placed on the market as finished gems was mined in previous years. The demand for tourmaline and kunzite declined and was supplied chiefly from stocks on hand. New trade names are continually appearing for new forms of well-known minerals or peculiar mixtures of minerals cut for gems. Some of these trade names are mentioned in this report in order that the public may know the nature of such stones when offered for sale.

ACKNOWLEDGMENTS.

Credit to persons furnishing information used in the preparation of this report is given in the text, but special acknowledgment for courtesies extended is due and cordially given to Messrs. J. J. Kinrade, of San Francisco, Cal., and J. H. Mosher, of Glendive, Mont.,

for information on moss agate and mocha stone occurrences in Montana; Mr. F. M. Myrick, of Randsburg, Cal., for specimens of St. Stephen stone for examination; Mr. F. C. Faxon, of Silver Lake, Cal., for specimens of copper-stained and amethystine chalcedony; Mr. Maynard Bixby, of Salt Lake City, Utah, for specimens of jasper-like chalcedony; Mr. W. B. Penniston, of Ashland, Oreg., for specimens of chalcedony and agate and notes on the localities; Mr. F. H. C. Reynolds for notes on occurrence of aquamarine near Royalston, Mass.; and Mr. George L. English, of Shelby, N. C., for information on emerald occurrences in North Carolina.

AGATE.

MONTANA.

Moss agate and mocha stone of fine quality occur in Montana. The agates have been found chiefly on the west side of Yellowstone River from the Dakota line up to and (reported) above Yellowstone Park. They range back from the river over many miles of country, where they are gathered by the ranchers and sheep herders. The agates are distributed over the surface of the ground, in the gravel along creek and river beds, and over some of the grass-covered buttes. The ones collected all lie at the surface or only partly buried. They occur in pebbles, cobbles, and in rough masses ranging from the size of a hazelnut to pieces weighing 12 pounds. Chemical tests made on a number of the black and reddish-brown spots broken from rough specimens showed the presence of both manganese and iron, confirming the generally accepted idea as to the nature of the dendrites in mocha stone.

The rough specimens of agate examined consist of fragments and a chipped pebble more than 2 inches thick. The rounded form of the pebble may be due in part to the shape of the cavity in which the agate was deposited and in part to attrition during transportation along with the associated gravels. The interior of the pebble and the fragments of agate consist of translucent gray to blue-gray chalcedony. Some of it shows a banded structure, and some an even texture. Black and brown dendritic spots are scattered irregularly throuh the agate and in places there are seams and irregular patches of the same color. Reddish-brown, red, and bright-red dendrites, banding, and other markings also occur in the agates. The texture of the dendrites ranges from cloudy patches to branching tufts and fibers as delicate as those found in the finest moss and ferns.

By taking advantage of the arrangement of the dark seams and dendritic patches, patterns are obtained that resemble moss, sea growths, ferns, rushes, trees, and even landscapes with water and islands. The cut gems consist of stones suitable for use in brooches, stick pins, watch fobs, belt buckles, etc. The markings were present in different shades of red, reddish brown, light brown, dark brown to black.

Three specimens cut into fob gems displayed very attractive markings. One of the fobs measuring 15 by 18 millimeters contained numerous black spots 2 to 3 millimeters in diameter, and one larger dendrite, 8 millimeters across, resembling a sunflower. Another fob stone 27 by 31 millimeters gave the effect of a small landscape, such as an overgrown garden with untrimmed shrubbery, hawthorn, or

other bushes. The shrubbery was represented by black dendrites 5 to 9 millimeters high.

The best specimen was an elongated stone cut "en cabochon," 73 millimeters long, 20 millimeters wide, and 5 millimeters thick, portraying many wooded islands scattered through a lake or other body of water—"Thousand Islands," as suggested by several persons who examined the stone. This stone is valued at $250. A slight banding of the agate heightened the resemblance to water and also added a slight cloud effect to the landscape. The fine quality of this gem was best brought out by viewing in transmitted light, though its great beauty was evident in reflected light. The scene was similar and very perfect viewed from either side of the stone. This gem would make a unique and beautiful brooch or would grace the collection of any museum in which it might be placed.

The gems cut from the Montana moss agate or mocha stone command good prices, bringing anywhere from $1 to $200 or $300 apiece. Some of the smaller stones suitable for stick pins, if the mossy or fernlike patterns are particularly delicate and beautiful, bring $25 apiece. Large quantities of agate are cut which yield less attractive gems, and stones as fine as those described above are rare. The value of such gems as have been described lies in the fact that they can not be duplicated.

CALIFORNIA.

Specimens resembling the St. Stephen stone variety of agate from a new locality 15 miles east of Indian Springs, San Bernardino County, have been examined. This stone has been called "myrickite" locally and a quantity has has been cut and sold for good prices. It has been obtained from a shallow shaft in a "malpais" lava hill where it occurs in bunches and small masses. It consists of translucent gray chalcedony through which bright blood-red spots and patches of color are irregularly distributed. In some specimens the red is thinly scattered through the agate and in others it is abundant. The majority of the red markings are irregular patches or tangled stringlike masses, but some are more or less round spots as in St. Stephen stone. The polished gems with the peculiar patterns of brilliant red in translucent chalcedony are highly attractive.

Specimens of copper-stained chalcedony from the south end of Death Valley, 5 miles west of the south end of the Mesquite Mountains, and of amethystine chalcedony about 8 miles south of this locality have been examined. The copper-stained variety is translucent and incloses spots and patches of blue and greenish-blue copper salts. The effect in some specimens is similar to that of the blue chrysoprase from Miami, Ariz. This chalcedony contains frequent small crystal-lined cavities so that careful selection would be necessary to secure material for cutting. The amethystine chalcedony is rather cloudy violet colored and massive and has a moderately even texture. It would cut into rather pretty low-priced gems.

UTAH.

Specimens of red jasper-like chalcedony and quartz have been received from a locality near San Rafael River, in Emery County, Utah. Much of this would be called chalcedony and agate or carnelian, but portions are so heavily impregnated with iron oxide as to

be more like jasper. In places the chalcedony grades into crystallized quartz. The material occurs in masses and aggregations of spherulites with mammillary and botryoidal structures. The spherulites range from minute size to over a centimeter in diameter and show a beautiful concentric agate banding of thin gray, white, and red layers. A radiated texture may or may not be visible and in some spherulites tiny radial quartz crystals occur in the center or in layers. A few of the spherulites exhibit very little internal structure or merely have spots of red near the center surrounded by gray chalcedony with even texture. In some specimens the spherulites are large or a number have been cemented together by chalcedony so that stones of sufficient size for cutting are obtained. Some of the gems are said to give the effect of thomsonite with deep jasper-red tints in gray matrix. As small fancy agates some of the larger spherulites would be very effective.

In some specimens spherulites of various sizes are thickly distributed through granular crystallized calcite. Many of the spherulites are isolated but some are bunched in botryoidal masses as shown when the calcite gangue is dissolved by acid. One specimen is described as resembling the cast of an ammonite shell. It was not possible to determine the nature of this from the sample submitted. It consisted of many spherulites cemented together with chalcedony with cavities lined with small crystals of quartz and calcite. The sample examined evidently came from a disklike specimen about 2 inches thick.

OREGON.

Chalcedony, agate, and jasper-like agate have been found near Rogue River and Eagle Point, and for some distance along Rogue River valley. The chalcedony is translucent and gray with a slight agate banding, and is found in streaks and nodules in the basalt near Ashland. Some of it contains cavities lined with quartz crystals. The agate is varicolored, ranging from banded translucent gray to mottled red and yellow, and some of it contains so much iron oxide as to resemble jasper. Two specimens labeled "red moss jasper" consist of opaque and translucent chalcedony crowded full with dark-red, reddish-yellow, and yellow mosslike markings of jasper. In other specimens of moss agate there are black to dark-brown spots and dendrites. One specimen found near the town of Klamath Falls consists of rather cloudy red chalcedony or agate, inclosing streaks and spots of gray and white chalcedony.

AMETHYST.

NORTH CAROLINA.

The occurrence of amethyst at several places in the vicinity of Raleigh, N. C., has been reported at different times by L. A. Fort, of that city. An opportunity was given to the writer to examine one of these deposits on the land of George W. Partin, 5 miles northeast of Raleigh. Here amethystine quartz and pale amethyst crystals are found on the surface of a cultivated upland field. Three or four small prospect pits, now filled up, had been made a few years ago. The deepest of these pits was about 9 feet, at which depth the rock was less decomposed than near the surface and hard to excavate.

The country rock is rather fine grained biotite granite gneiss, inclosing pegmatitic seams and streaks. The granite has disintegrated to a light sandy soil at the surface and into a friable sandy saprolite to a depth of a few feet below the surface. The amethysts are found in the soil for a distance of about 150 yards in a northeast-southwest direction. Near the prospects they are very abundant, since many that were dug out had not been carried away. Probably 2 or 3 bushels of amethystine quartz crystals could have been collected in half a day from the surface of the ground. In the prospects, Mr. Fort states, the amethyst crystals were found in streaks and seams with a northeast direction, two or three parallel seams occurring within a space of a few feet.

The crystals are only moderately well developed, owing to mutual interference during growth, and nearly all have been somewhat fractured. Some of them have been only slightly chipped and others possess few if any crystal faces. The amethystine quartz and amethyst occur in pieces ranging from those of small size to those 2 or 3 inches across. Aggregates of crystals in parallel growth also occur, some of which consist of both colorless or smoky quartz and amethystine quartz. Many of the crystals are quite clear and transparent, but this is often partly concealed by etched and rough faces. The best specimens found on the surface and in the prospects had been carried off and no dark-purple amyethysts were seen. A few stones with sufficient depth of color to warrant cutting were seen, but the gems obtained would not be of the best quality. The abundance of amethystine quartz and amethyst found close to the surface at this locality invites more extended prospecting.

Mr. Fort says he has also found amethyst loose in the soil on the land of the late Capt. F. F. Ellis, 3 miles east of Raleigh.

Amethyst has also been reported from Warren County, N. C. Mr. Fort mentions a deposit on the land of Mrs. G. W. Alston, of Inez. Several years ago a prospect was opened by a clergyman at Folly Springs, near Warrenton. Some excellent crystals are said to have been found there. The principal rock of this part of Warren County is granite gneiss belonging to the same belt as that around Raleigh, nearly 50 miles southwest.

Amethyst has been found at a number of places farther west in the Piedmont Plateau region in Iredell and Lincoln Counties, N. C. A few of these are here mentioned. At some of the localities a little prospecting has been carried on and at others crystals have been found loose in the soil. In Iredell County a prospect was opened a number of years ago on the A. C. Cook place, 9 miles southeast of Statesville. A large quantity of pale amethyst and amethystine quartz crystals were found in seams and veinlets cutting coarse pegmatitic granite. Only a few stones of fairly good color were found, though many were suitable for less valuable gems. Amethystine quartz was found abundantly. A few pale amethysts have been found in the soil on the land of Mrs. M. G. Martin, about one-half mile east of the Cook place, and on Burette Brawley's place, 1½ miles south of Cook's. Maj. W. A. Graham, of Raleigh, reports an occurrence of amethyst in Lincoln County on the Erhard Forney place, 1 mile from Denver and on the Rendleman place, 2 miles from Iron Station. Good crystals of amethyst found in Lincoln County were seen in a local mineral collection at Lincolnton.

BERYL.

MASSACHUSETTS.

Aquamarine was found during 1910 at the "Beryl Hill" mine, near Royalston, Mass. No systematic mining was done, but during prospecting some excellent specimens of aquamarine were uncovered. Some of this had a brilliant blue aquamarine color and cut into fine gems. One stone weighing 12 carats was sold for $100. The best specimen was an almost perfectly clear crystal measuring about 3 inches long, 2¼ inches wide, and three-fourths of an inch thick.

From a manuscript copy of a "Mineral lexicon of Worcester County, Mass.," by Prof. B. K. Emerson, of Amherst College, it is learned that prospecting was continued at the "Beryl Hill" mine (during 1911) and a number of beautiful beryl crystals ranging in thickness from 1 inch to 2 inches were found. These crystals were pale to true sea-green and some had the typical "blue beryl" color. The quality and brilliancy were especially fine. A few dark orange-colored beryl crystals were found also. Extensive mining was planned for 1912.

BRAZIL.

A remarkable crystal of beryl found in Brazil on March 28, 1910, has been described by George F. Kunz,[1] in a paper read before the New York Academy of Sciences on April 3, 1911. The crystal was found in a pegmatite vein in Marambaya, a village near Arassuahy, on Jequitinhonha River, in the State of Minas Geraes. It was the largest precious beryl or aquamarine crystal ever found, weighing 110.5 kilograms and measuring 48.5 centimeters high and 40 to 42 centimeters in thickness in different directions. The crystal was a simple hexagonal prism with basal planes with a few irregularities. It was so transparent that one could see through it from end to end. The color was greenish blue, and the crystal was free from included impurities. This beryl crystal was found by a Turk in what is known as a "primitive mine," at a depth of 5 or 6 meters. It was transported by canoe with great difficulty down Jequitinhonha River to the coast and shipped to Bahia, where it is said to have been sold for $25,000. It is estimated that 200,000 carats of aquamarines of various sizes could be cut from this beryl.

BOWENITE.

NEW ZEALAND.

Notes on the discovery and occurrence of a deposit of bowenite or "greenstone" in New Zealand have been given by Vice Consul General Henry D. Baker and Consul General William A. Prickitt.[2] Bowenite has been classed under serpentine in Dana's "System of mineralogy" and is stated to have a hardness of 5.5 to 6. Bowenite has been found loose in the beds of streams by the Maoris of New Zealand and, under the name "tangiwai," has been fashioned into ax heads, ornaments, and jewelry. The new locality is near Milford Sound, on the west coast of the South Island of New Zealand. A large outcrop of the bowenite has been found in a hitherto unexplored mountain

[1] Min. and Eng. World, July 8, 1911. [2] Daily Cons. and Trade Reports, Feb. 2, 1912, pp. 856-857.

region. The mineral is so massive and plentiful that it can be used for mantelpieces, table tops, and similar ornamental work. It should meet with the approval of the Chinese, by whom other forms of greenstone are held in peculiar veneration. Dr. P. Marshall, of Otago University, describes the bowenite from the new locality as unequaled in quality, and perfectly adapted for the making of ornaments, knife handles, and other purposes for which such a beautiful stone may be required. The extreme and peculiar beauty of the stone would be likely to make the demand increase enormously. Bowenite differs from nephrite (the ordinary greenstone) in its beautiful transparency, less crude color, and in hardness.

Old Maori legends tell of the loss of the original "tangiwai" deposit in a landslide on the slopes of Anita Bay. The location of the new discovery corresponds closely with that given in the native legends. Samples brought to Auckland have been pronounced the real "queen of greenstones" by Maoris and valued above all other varieties.

Some of the bowenite is translucent in moderately thick pieces and permeated with irregular cloudy waves; the ordinary greenstone is translucent only in very thin slices. The ordinary material has sold for 12 cents a pound, but will doubtless be much less in demand and cheaper in the future.

CALIFORNITE (VESUVIANITE).

CALIFORNIA.

Occurrences of californite have been mentioned in several of these reports during the years 1901 to 1910, and detailed descriptions of some of the localities have been published as follows: In the report for 1906 notes on a deposit near Exeter, in Tulare County, were given by Frank L. Hess, of the United States Geological Survey; in the report for 1909 the prospect of C. N. White about 6 miles east of Lindsay was noted; and in the report for 1910 the original californite locality 10 miles west of north of Happy Camp, Siskiyou County, was described. Other localities are known and two of them are described below. One of these is in Butte County and has been prospected as a side issue by the North California Mining Co.; the other is in Fresno County, and at present the claims are owned by the Prethero Bros. and Nat Parker, of Visalia.

The prospect of the North California Mining Co., which has been examined by the writer, is on the west side of North Fork of Feather River about half a mile northeast of Big Bar station on the Western Pacific Railway. It is in a steep rocky hillside, almost a cliff, over 200 feet above the railroad tracks, or about 1,600 feet above sea level. The hillside has only small trees and bushes growing among the rocks and ledges. The mountains around are covered with a heavy growth of timber, among which are spruce, red fir, oak, and sugar pine. The californite was discovered about four years ago when a wagon road was graded along the hillside to facilitate the construction of the railway. Some of the mineral had been previously cut with good effects. Specimens seen in 1909 was green to white and some were nearly colorless and transparent, resembling so-called chalcedony moonstone. Some pretty apple-green and lily-green gems, showing an even quality of color and transparency, have been cut.

The californite was exposed in the roadside where a cut nearly 15 feet high had been blasted through rock. Several masses of the mineral had been broken up and removed during road construction, and the lead exposed was further prospected by a tunnel about 16 feet long driven into the hillside in a N. 70° W. direction.

The country rock consists of greenish-gray, yellowish-green, and greenish-black serpentine cut by streaks of gneissic diorite, hornblende schist, and seams of talc. The serpentine mass in which the californite occurs is over 200 yards thick and is in contact with gneissic diorite on the northeast. On the southwest, at a distance of about 65 yards from the prospect, there is a series of gray and black slate or phyllite, quartzite, graywacke, and blue and white marble and limestone. The serpentine has been crushed to lenticular masses with many slickensided seams. The californite occurs in a belt of badly fractured serpentine some 12 feet thick with an east-west strike and dip of about 80° N. Lenses, nodules, and streaks of californite are irregularly scattered through the gem lead. The streaks range from less than an inch to several inches thick and the nodules and lenses also range from the same small size to nearly 3 feet thick. One lenslike mass exposed in the tunnel was nearly 3 feet across and from it a streak 3 to 4 inches thick extended several feet to the end of the tunnel. There is a thin deposit of a hard flesh-colored mineral with a granular crystalline texture between most of the californite and the serpentine.

The color of the californite ranges from bluish green or yellowish green to white and gray with a tint of pink. Pale yellowish green is the most common color, and some of this californite grades into darker green and into white or gray in the same masses. Part of the green, gray, and white material is translucent and part is opaque. In some of it the color is evenly distributed through large areas, and some contains a few darker green patches and spots similar to some of the californite from the C. N. White mine, near Lindsay, in which the patches of color were shown to be caused by chromium compounds. Seams and cracks or joints occur through all of the californite, so that flawless specimens of good color and quality more than 2 or 3 inches thick are rare. Many of the cracks are not sufficiently pronounced or have been recemented so that the strength of the stone has not been greatly injured and the californite can be cut regardless of them if larger pieces are desired. Larger cracks occur along some of the joint planes and form lines of easy parting or fracture in the californite.

The californite locality of the Prethero Bros. and Nat Parker is about 30 miles northeast of Sanger and 32 miles east of Fresno. It is on the east side of Watts Valley about 1½ miles south of Hawkins schoolhouse. The prospects are at elevations of about 2,000 feet above sea level, or some 700 feet above Watts Creek. The mountain side is steep and has a thin soil cover over talus and débris slopes. The principal vegetation is brushy live oak, poison oak, and stiff wirelike grass. The californite has been obtained from several prospect pits in a northwest-southeast belt. The rock formations are varied, but the californite occurs in a serpentine complex in which are chloritic and talcose soapstone phases. Fine and coarse diorite and epidotized diorite also occur near the californite deposits. Little could be seen of californite in place at the prospects visited, but it evidently occurs

in lenses, streaks, and nodular segregations in the serpentine as at the Butte County locality described above. Some of the masses of californite were at least several inches thick and larger ones were probably found. Joints, cracks, and seams are numerous, and large flawless pieces are rare. The californite found here is grass-green, with a tint of yellow, lemon-green, pale yellowish green, and nearly white. It is translucent in the better specimens and much of it is evenly colored. In some of the material there are occasional darker spots or patches as in the californite described above. Considerable of the better grade from this locality has been cut by the Southwest Turquoise Co., of Los Angeles, and beautiful gems have been obtained. Stones for stick pins, brooches, cuff bottons, pendants, and necklaces cut from the grass-green or lemon-green material are extremely pretty.

The specific gravity of californite is variable. George F. Kunz[1] gives the specific gravity of the Siskiyou County californite as 3.286. F. W. Clarke and George Steiger[2] give 3.359 as the specific gravity for green vesuvianite from Fresno County, and 3.586 for compact white garnet from about the same locality. J. E. Pogue, of the National Museum, found the specific gravity of the white californite from Siskiyou County to be 3.57. Determinations made with the Jolly balance give 3.410 for green, 3.470 for pale yellowish green, and 3.599 for white californite from Butte County, and 3.351 for green californite from the deposits of Watts Valley, Fresno County. As pointed out in this report for 1910, it is difficult without an analysis to make a distinction between compact vesuvianite and compact garnet. The series of specific gravities cited indicates a gradation from one to the other, the specific gravity of californite being greater in the lighter colored varieties. Under the microscope green californite from Butte County has the low double refraction characteristic of vesuvianite and white californite from the same prospect is isotropic like garnet.

As the green and white material occur together and grade into each other both in color and in weight, the term californite should include both. In ordinary physical characters, such as hardness, toughness, luster, and fracture, the compact vesuvianite and the compact garnet are apparently identical and do not differ greatly from green and white jade. The color also of some varieties of californite is not unlike that of jade, but the material from the two localities described is rather too yellow for substitution for that mineral. Consul General S. S. Knabenshue, of Tientsin, China,[3] says, concerning a sample of california jade, that the leading firms of that city to whom it was submitted "declared that jade of this particular greenish color has no commercial value in the Chinese market. The jade which is most esteemed is semitransparent, of a clear emerald-green. Next to this white jade stands in greatest favor. The color seems to be the point most insisted on." It is probable that this statement was made in regard to californite from the North California Mining Co.'s property, since that company received a similar reply concerning a sample sent to China in search of a market. It seems that the choice of the Chinese does not rule out white californite and such material should be submitted to Chinese merchants for valuation. This has been found

[1] Gems, jewelers' materials, and ornamental stones of California: Bull. California State Min. Bur. No. 37, 1905, pp 93–95.
[2] On californite: Bull. U. S. Geol. Survey No. 262, 1905, pp. 72–75.
[3] Daily Cons. and Trade Repts., Oct. 25, 1911.

in some quantity in Siskiyou County and Butte County, and some of it contains a few emerald-green spots. The green californite from Siskiyou County is not greatly different in color from jade used for earrings by the Chinese and is mottled with similar patches of green.

CHRYSOPRASE.

CALIFORNIA.

In the description of the chrysoprase deposits of Tulare County, Cal., in this report for 1909, a prospect of the Himalaya Mining Co. near Lindsay was mentioned in connection with the notes on that company's mine, three-fourths of a mile north of town. This prospect was examined in 1911. It is in the top of a low hill about a mile S. 70° E. of Lindsay. The hill is about one-third of a mile long in a N. 25° W. direction. It rises about 60 feet above the plains at the ends and is lower in the middle. Several small prospect pits and trenches had been made, chiefly at the north end of the hill, but little gem chrysoprase was found. The occurrence is similar to that of the other deposits. Jaspery and cherty serpentine heavily stained with yellow and red iron oxides outcrops along each end of the hill in rough ledges and masses. Fine-grained diorite forms the west central portion of the hill. The jaspery serpentine is cut in many directions by seams and veinlets of chalcedony and fine-grained chalcedonic quartz, ranging from paper thickness to 2 or 3 inches thick. In some of these veinlets there was a slight tint of green, but no chrysoprase was observed. Veinlets of greenish and yellowish-green opal are also plentiful through the jaspery serpentine.

The production of chrysoprase in 1911 came from the mine of the Himalaya Mining Co., 8 miles southeast of Porterville, and from some of the deposits on Venice Hill, 8 miles east of Visalia. Some high-grade gem material was obtained at each locality. A quantity of low-grade chrysoprase and some chrysopal are obtained during mining. These are generally shipped to Germany for cutting.

ARIZONA.

The occurrence of chrysoprase about 20 miles west of Mineral Park, in Mohave County, Ariz., was mentioned in this report for 1908. The deposits are owned by John L. Riggs and Walker Bros., of Chloride. The occurrence is quite different from the California localities. Specimens sent by Mr. Riggs were decomposed fine-grained rhyolite porphyry with small quartz phenocrysts and perlitic volcanic glass country rock. Associated minerals of the chrysoprase were black flint, red and brown jasper, gray and white chalcedony, and quartz. Some of the specimens were brecciated and contained fragments of chrysoprase. So far high-grade gem material has not been found, but the brecciated matrix containing chrysoprase would furnish unusual and attractive gems for the tourist and souvenir trade. Large lumps of rather granular opaque chrysoprase have been found which could be cut into small ornaments.

The so-called "blue chrysoprase," or copper-stained chalcedony, from the Keystone and Live Oak copper mines near Miami, Ariz., was described in this report for 1909. Very little of this material is now obtained from the mines, as the workings have been carried

below the levels in which it occurred. The small quantity now cut probably comes from stocks set aside while those parts of the mines were being worked, and from random lots still obtained by "jayhawkers" from old stopes.

DIAMOND.

ARKANSAS.

Conditions in the Arkansas diamond region of Pike County have been briefly summed up by John T. Fuller.[1] Prospecting during the last five years has demonstrated two diamond-bearing pipes. Washing to date on the original area of discovery has yielded 28 carats of diamonds per 100 loads of 16 cubic feet of earth washed. Little development was done in 1911 through lack of capital. The most important find of the year was an 8⅛-carat white diamond on the Mauney tract, a portion of the original pipe. This is the largest diamond so far found in Arkansas. Another white diamond of 3 7/16 carats was found on the property of the American Diamond Mining Co. It is also the largest stone yet found on this property.

The Arkansas Diamond Co. reports that its mine was not operated during 1911, but that a small amount of washing was done resulting in the recovery of 155 stones weighing 45⅝ carats. Press reports of the discovery of a big diamond in the Mauney mine[2] place its weight at 10 to 14 carats, one of the articles stating that the stone had not been weighed at that time. The diamond is described as "blue-white, apparently flawless, and wedge shaped." No information about the stone was given to the Survey by Mr. Mauney, but it is doubtless the same stone whose weight is given as 8⅛ carats by Mr. Fuller. In a communication received from the secretary of the American Diamond Mining Co., a diamond weighing 2 7/16 carats is reported to have been found on the company's property by Mr. Reece Lamb, vice president. This stone has been valued at $165 per carat and might lose 40 per cent in cutting. It is doubtless the same stone referred to by Mr. Fuller as weighing 3 7/16 carats.

CALIFORNIA.

Mr. M. J. Cooney reports that three small diamonds were found in the Cherokee Flats region, Butte County, Cal., during 1911. These stones were obtained by placer miners, washing for gold in the same way that all the diamonds of that region have been found. One of these stones of one-fourth carat weight is said to have come from ground owned by the United States Diamond Mining Co., of which Mr. Cooney is president.

TEXAS.

Attention was called by Mr. T. E. Willson, editor of the Jewelers' Circular Weekly, to a reported discovery of diamond in Texas, and further information furnished by correspondents was given. The Geological Survey has not examined the locality. The discovery is claimed by Fred. W. Packer in Montgomery County, Tex., who states that he noticed the resemblance of certain formations

[1] Eng. and Min. Jour., Jan. 6, 1912, p. 6. [2] Jewelers' Circular Weekly, June 21 and June 28, 1911.

of Montgomery County to those of the South African diamond mines and commenced prospecting. A badly flawed diamond weighing 2¼ carats is reported to have been found and indications are that more thorough prospecting will be done. A stone reported to have come from Montgomery County was shown to the Sweeney Jewelry Co., of Houston, Tex., and was pronounced diamond. In a communication to the United States Geological Survey Mr. Packer states that the diamond was found 4 miles north of Montgomery and weighed 3½ carats.

ILLINOIS.

A discovery of diamond has been reported in Jefferson County, Ill. Mr. Austin Q. Millar, of St. Louis, informed Dr. F. W. De Wolf, of the State Geological Survey of Illinois, in a letter dated February 9, 1912, that a man had displayed 22 diamonds to the Eisenstadt Manufacturing Co., of St. Louis. The largest of these stones weighed 7¼ carats. Mr. Eisenstadt, of the Eisenstadt Manufacturing Co., informed the writer that the stones were genuine and were reported to have come from the vicinity of Macomb, Ill., by C. L. Goulding, a jeweler of Alton, Ill. A press report [1] gives the locality as the farm of Matthew Fox, near Ashley, and states that the stone weighed 7¼ carats and would yield a gem worth about $225. A letter from Mr. Fox to the writer, dated Wood River, Ill., April 29, 1912, gives the following information: The diamond was found in Jefferson County about a year ago on the farm of T. H. Bledsoe, about 3½ miles east of Ashley. It was found on a sloping piece of ground in the gravelly soil of a cornfield a few yards from a stream. It weighed 7 carats and was purchased by a firm in Alton for $175.

AFRICA.

UNION OF SOUTH AFRICA.

Cape Colony.—The output of diamonds during the fiscal year 1911 by the De Beers Consolidated Mines [2] amounted to 2,180,856 carats, valued at £4,938,087, as compared with 2,416,666 carats, valued at £5,414,896, in 1910. The total production of blue ground in 1911 amounted to 8,105,138 loads, as compared with 5,111,524 loads in 1910. The total amount of blue ground washed was 9,219,192 loads, as compared with 8,531,000 loads in 1910. The stock of blue ground and lumps on the floors was increased from 7,776,059 loads in 1910 to 9,021,026 loads in 1911. The De Beers mine has not been reopened since it was closed in 1908. The surface equipment is being remodeled. Blue ground from the depositing floors of all the mines was washed. The yield in carats of diamonds per load of blue ground washed decreased from 0.38 to 0.28 at the De Beers and Kimberly mines, from 0.32 to 0.27 at the Wesselton mine, and from 0.23 to 0.21 at the Dutoitspan mine. The yield per load of blue ground washed increased from 0.37 to 0.38 carat at the Bultfontein mine.

Transvaal.[3]—The production of diamonds in Transvaal during the fiscal year ending June 30, 1910, amounted to 2,098,528 carats, valued at £1,317,479—an increase of 169,036 carats in quantity and of

[1] Jewelers' Circular Weekly, Apr. 17, 1912.
[2] Twenty-third Ann. Rept. De Beers Consolidated Mines, for year ending June 30, 1911.
[3] Ann. Rept. Govt. Min. Eng., Transvaal, 1910.

£22,183 in value over 1909. The Premier diamond mine continues to be the principal producer, but several other mines and the alluvial diggings at Christiana contributed to the output.

Orange Free State.[1]—The total production of diamonds in the Orange Free State (formerly Orange River Colony) during the fiscal year ending June 30, 1910, amounted to 787,614 carats, valued at £1,525,707, as compared with 654,319 carats, valued at £1,048,607, in 1909. The principal output came from the Jagersfontein, Koffyfontein, Voorspoed, Roberts, Victor, and a few other mines, but the alluvial diggings along Vaal River contributed 1,653 carats, valued at £6,983. At the mines 8,027,487 loads of blue ground were washed, yielding 10.19 carats of diamonds per 100 loads of ground. The yield per 100 loads washed was less than in 1909, but the average value obtained per carat was greater. The value of the diamonds from the alluvial diggings averaged more than twice as much as those from the mines. Among the largest diamonds found in the alluvial diggings was one of 38 carats, valued at £250, and another of 24 carats, valued at £272.

BELGIAN KONGO.

The discovery and occurrence of diamonds in Belgian Kongo has been described by Sydney H. Ball.[2] A few stones were found both in the tributaries of Lualaba River, and in that river itself by prospectors of the Tanganyika Concessions Co. during the years 1906 to 1910. These diamonds were found in gravels and the concentrates with which they were associated contain garnet, diopside, diallage, biotite phlogopite, olivine, zircon, wollastonite, aragonite, calcite, and goyazite. A rock similar to kimberlite is reported to occur in the Kundelungu Plateau, east of the diamond localities, cutting red sandstones of "Permo-Carboniferous" age.

In 1906 American and Belgian capitalists took over a mining concession in Belgian Kongo under the name Société internationale forestière et minière du Congo. One small diamond of fine quality was found by a prospector near Mai Munene in Kasai River. Work was recommenced in 1911 and many diamonds were found. At one place, about 55 miles northwest of Mai Munene 240 stones were found in two weeks by one man. So far diamonds have been found for a distance of about 75 miles along Kasai River, and in the lower parts of its tributaries. They occur in riffles or potholes in the river bed or in sands along their banks and are locally abundant. Some of the gravel has a rather weak limonite cement. The majority of the stones are well crystallized. The common forms are octahedrons with some dodecahedrons and a few trisoctahedrons. Curved faces, etching, and twinned crystals are common. A large percentage of the stones are white, the others are mostly yellow and off-color, but some deep-yellow, topaz, and apple-green stones occur. Associated minerals are gold, quartz, cyanite, magnetite, zircon, ilmenite, feldspar, mica, garnet, epidote, rutile, and hematite, in addition to carnelian, chalcedony, agate, jasper, chert, diorite, schist, and granite pebbles.

[1] Seventh Ann. Rept. Mines Dept. Orange Free State, 1910. [2] Eng. and Min. Jour., Feb. 3, 1912.

The basement rocks of the region are micaceous schists, quartzite, granitic, and basic igneous gneisses intruded by granites, diabases, and gabbros. They are older than "Permo-carboniferous" and are probably of pre-Cambrian age. On this basement series "Jura-triassic" sandstones and shales were deposited. These sandstones and shales now form a blanket over the central basin of Kongo River. The deeper streams have cut through them to the basement rocks, and it is in such a stretch of Kasai River that diamonds have been found. The diamonds may have originated from one of the basic igneous rocks of the older series, or have formed pebbles in the sandstones. It is thought to be more probable they will be found in basic intrusive masses cutting "Jura-triassic" sandstone. It is interesting to note that these beds are the stratigraphic equivalent of the youngest sedimentary rocks cut by the kimberlite of South Africa.

GERMAN SOUTHWEST AFRICA.

According to Consul General T. St. John Gaffney,[1] the diamond fields in German Southwest Africa have not come up to expectations after five years of development. The dividends paid by the Colonial Mining Co., the Kolmanskop Society, and the German Diamond Society have fallen off considerably and the Lüderitzbucht combined companies paid no dividends in 1910. Difficulties reported are the exhaustion of the rich supply of the surface diamonds, requiring more costly mining methods, a shortage of labor, and an export tax of 33⅓ per cent of the gross value of the diamonds.

NOTES ON DIAMOND.

Larger diamonds of South Africa.—L. J. Spencer[2] has given a list of 26 of the larger diamonds of South Africa, with their weights, the number of stones cut from many of them, etc. Twenty-five of these diamonds weighed over 100 carats each, and nine of them yielded single cut gems of over 100 carats weight. Of 13 of the diamonds the yield of cut gems ranged from 34½ to 59 per cent. Among the diamonds mentioned are the Cullinan, Excelsior, Jubilee, Imperial, Tiffany yellow, and Star of South Africa. Errors and uncertainties concerning the weight of some of the stones are corrected and adjusted, thus: The Excelsior diamond is shown to have weighed 969½ carats, the Jubilee 634 carats, and the Imperial approximately 456½ carats.

Metric carat.—In the article mentioned Spencer calls attention to the difficulty of getting the correct weight of many gems, especially of those of international interest, when a standard weight of measure is not used and when the word "carat" means something different in different countries. The simplicity of the metric carat of 200 milligrams as a substitute for the variable carat weight of many countries is made evident. The metric carat is 5.304 milligrams lighter than the English carat. It has been legalized in Bulgaria, Denmark, France, Germany, Holland, Japan, Norway, Portugal, Roumania, Spain, Sweden, and Switzerland. The metric carat became official in Germany[3] on April 1, 1911, and should be adopted by all countries for simplicity and convenience.

[1] Daily Cons. and Trade Repts., Sept. 6, 1911.
[2] Mineralog. Mag., vol. 16, October, 1911, pp. 140-148.
[3] Jewelers' Circular Weekly, Apr. 17, 1912.

EMERALD.

NORTH CAROLINA.

Emerald is ranked among the few really precious stones and by some people is considered the most valuable. It has been prized from early times because of its beauty and rarity. The number of localities where good gems have been found is few, and some of those once known have been forgotten. The following notes on foreign localities are taken from a book by Max Bauer.[1] Emeralds found with the mummies of Egypt probably came from the mountains along the west coast of the Red Sea in Upper Egypt, where ancient workings were discovered during the nineteenth century. Mines in the Salzburg Alps are said to have been worked intermittently for emeralds since the time of the Romans to the present. The world's principal supply of emeralds has come from South America. They were first brought to Europe from Peru by the Spaniards in the sixteenth century. None are now found in that country, and it is thought that the Peruvians obtained them from Colombia. Three mines were worked by the Spaniards in Colombia. Later two of these were lost, and for many years the only mines worked were those near Muzo. Recently the lost mines of Somondoco were found on the east side of the Andes Mountains at an elevation of about 9,000 feet above sea level.

Fine emeralds have been found in the Ural Mountains about 60 miles east of Ekaterinburg. This locality was discovered in 1830 by a peasant, who noticed the stones among the roots of a tree torn up by the wind. A few other European localities are known. Emeralds have been found at two localities in Australia. The most promising one is near the township of Emmaville in New South Wales.

Several localities in the United States have yielded emeralds, but the best specimens have come from North Carolina. In Maine a few stones have been found at Topsham and a pale-colored stone at Newry. A few crystals are reported to have been found at Haddam, Conn.

In North Carolina three localities are now known where good emeralds occur. The first of these to be discovered was in Alexander County in 1875 by J. A. D. Stephenson, of Statesville, N. C. This locality was later developed into the emerald-hiddenite mine near the present railroad station, Hiddenite. The second locality was discovered in 1894 by J. L. Rorison and D. A. Bowman on Crabtree Mountain in Mitchell County. Both of these deposits were developed on a fairly large scale and a few fine gems were obtained from each. Progress at the third emerald locality described below has been given in these reports for 1909 and 1910. The deposit is on the land of W. B. Turner, 4¾ miles S. 30° W. of Shelby, near the east bank of First Broad River, in Cleveland County. Some 15 years ago two emeralds were found loose in the soil on the Borders farm about 1 mile east of Mr. Turner's. Further search failed to discover more gems and prospecting was given up. Subsequent investigation indicates that these stones were transported by residents or farm hands on the Turner plantation to the adjoining place during friendly intercourse of long standing.

[1] Precious stones [translation by L. J. Spencer]; Charles Griffin & Co., Ltd., London, 1904, pp. 309 et s

The attention of the writer was called to the discovery on the Turner place by Mr. George L. English, of Shelby, to whom acknowledgment is due for many courtesies and much information. The first visit to the prospect was made in December, 1909, at which time no digging had been done, but about a dozen emeralds had been found loose in the soil of a cotton field. The locality is in a rather roughly dissected portion of the Piedmont Plateau, such as is generally found along the larger creeks and rivers. The elevation is about 680 feet above sea level, or about 30 feet higher than First Broad River near by. The higher ridges of the Piedmont Plateau in the neighboring country are about 800 to 850 feet above sea level. The crystals have come from an area of about 100 feet by 25 feet on a hillside of moderate slope to the northwest. The slope is toward the river on the west about 150 yards and toward a small stream entering the river from the northeast. The field in which the emeralds were found had been cultivated and they were exposed by plowing and by the washing of rains.

Prospecting up to December, 1911, consisted of the digging of several pits and trenches, some of which had been filled up. The largest working was a crosscut trench over 100 feet long and from 2 14 feet deep. This work was done by Mr. Turner and Mr. English during 1909, 1910, and the first part of 1911. The property was optioned and leased by Lovat Fraser, of New York, and prospected during the last part of 1911 and the first part of 1912. In the spring of 1912 it was purchased by Messrs. Fraser and E. P. Earle, of New York, and will be extensively prospected. Excavations have been carried deeper by Mr. Fraser than when last examined by the writer. Promising finds of emeralds have been made at each working, but these discoveries have been followed by periods of uncertainty as to the continuity of the vein.

The crystals found loose in the cotton field had a fine dark-green color, but were somewhat checked and flawed, and some contained silky internal markings. The largest of these emeralds and the best specimen so far found measured about 1 inch by three-fourths of an inch by half an inch. It was about half of a crystal split parallel with the length. This piece has been cut into about 20 gems, the largest of which is a faceted stone weighing about 3 carats. This stone has been described as having an excellent deep-green color and as being particularly beautiful at night. It has almost no visible flaws but is slightly foggy in strong daylight. The other gems cut from this crystal are of similar quality, but some contain more flaws. The other stones found on the surface ranged down to less than a carat in weight in the rough and most of them were deep green. Some were nearly whole crystals and others were fragments of crystals. All were rather strongly etched and striated. Very pretty gems have been cut from smaller fragments of crystals found on the surface. Some of these were sold at rather low prices before their true value was realized and the proceeds were devoted to prospecting. These gems brought $10 to $30 per carat. A lot of 11 of these emeralds cut "en cabochon," weighing about 9 carats, have been mounted in a small necklace and would bring several hundred dollars at retail prices.

Gems cut from emeralds removed from the vein have also proved good quality but are probably not quite so deep in color as those

found on the surface. The crystals from the vein range in size from that of a portion of a large needle to a broken specimen measuring seven-eighths of an inch thick and nearly 5 inches long. Some of these emeralds have fairly well developed crystal faces, but the majority are roughly striated and pitted, though retaining a rude hexagonal outline. In some specimens no trace of crystal form remains. As usual with emeralds, only small pieces are free of flaws and imperfections. Many crystals contain slight checks across their length, and in some the flaws lie at all angles. Some stones are cloudy and others contain fine internal striations or silkiness. Stones in which this is pronounced give a fine cat's-eye effect when tipped to and fro. Small crystals have been found that will cut practically flawless stones up to one-half carat in weight, and even in such small gems a flawless emerald of good color is very rare. The quality of many of the emeralds can not be judged from their external appearance, as the exterior is badly striated and by reflection of the light makes the stone appear both of lighter color and more imperfect than it really is. The average of the emeralds from the Turner mine has been pronounced equal in quality to the average run of Colombian emeralds, and New York dealers are beginning to recognize the beauty of the North Carolina gem.

Mr. Fraser has furnished an estimate of the total quantity of emeralds obtained from the Turner mine along with notes on a few of the gems cut from vein material. The exact weight could not be given, as some of the stones were cut and sold before the property came into his charge. In all about 2,700 carats of rough stones have been found. So far over 200 carats of gems have been cut and to judge from the yield in cutting, about 700 carats of cut gems ought to be obtained from the 2,700 carats of rough material. From the rough material selected as fit to cut, the yield of gems has been about one-third. The cut gems have been valued at $5 to $200 per carat wholesale, and a moderate estimate of the average value would be $15 per carat.

One lot of 27 cut stones ranging up to over a carat in weight, seen by the writer, contained some fine stones. One of these with a table cut, weighing 0.83 carat, was a fine, clear, dark-green gem with only a slight flaw. This stone has been variously estimated by lapidaries and dealers as worth from $125 to $200. Reputable lapidaries valued it at about $200 per carat. Other stones in this lot are worth up to $90 per carat, but some would probably not bring over $10 to $25 per carat. Mr. Fraser mentions a lot of smaller gems, chiefly about one-fourth of a carat in weight, but some at least half a carat, which are "brilliant, very clear and clean, and of good green color." One oblong faceted stone of about 1 carat has a good color, is clear, and is not badly flawed. It is considered one of the best gems found. Another fairly clear and fairly brilliant gem weighing 2¼ carats and having a good color has been classed by a lapidary as one of the most important gems. An attractive gem is a long tapering drop weighing 20 carats. It has an excellent color and is clear in spots.

Before taking up the discussion of the geologic occurrence of the emerald a few notes on its nature and modes of occurrence at other localities will be given for comparison with the new locality.

Emerald is a variety of the mineral beryl. Beryl is a silicate of aluminum and beryllium containing a small per cent of water. Small

quantities of other elements may be present and in some stones influence the color. Thus, beryl containing cæsium is generally colorless and very brilliant; the presence of lithium produces the pink beryl, and chromium the emerald. Other color varieties of beryl are aquamarine, blue beryl, and golden beryl. A small per cent of chromium oxide is sufficient to impart a rich emerald-green to beryl. According to Bauer,[1] an analysis by F. Wöhler of Colombian emerald gave 0.186 per cent chromium oxide.

Beryl crystallizes in the hexagonal system and commonly occurs in six-sided prismatic crystals terminated by the base with or without other faces. In emerald simply the prism faces and base are the most common. Beryl is nearly always found crystallized, even when "frozen" in hard rock. Crystals that have developed in cavities are in some cases beautifully developed.

The following notes on the occurrence of emeralds in Colombia, Egypt, the Ural Mountains, and Salzburg Alps are taken from Max Bauer.[1]

In Colombia emeralds occur in calcite veins and nests in dark bituminous limestone. The limestone overlies red sandstone and clay slate of Cretaceous age. The calcite may be dark with bituminous matter or clear like Iceland spar. Associated with the emeralds are fine quartz crystals, both colorless and green, pyrite, green gypsum, black dolomite, and parisite, a fluo-carbonate of cerium, and other rare metals. In Upper Egypt the emeralds occur in dark mica schist interfoliated with talc schist, and at one locality these rocks contain also augite and hornblende. The occurrence in the Ural Mountains is said to be very similar. In the Salzburg Alps the matrix is described as somewhat similar and consists of finely granular dark brown and greenish mica schist interfoliated with chlorite and hornblende schist.

The emeralds found in Maine and Connecticut were associated with pegmatite.

At the emerald-hiddenite mine in Alexander County, N. C., emeralds have been found in pockets and cavities in veins cutting biotite gneiss. The gneiss has been strongly compressed and folded while in a plastic condition. In the neighborhood of the veins it has been highly silicified by the addition of much quartz which, along with muscovite, rutile, pyrite, etc., has replaced the biotite and feldspar. The minerals filling the veins are quartz, calcite, dolomite, muscovite, rutile, black tourmaline, pyrite, chalcopyrite, monazite, aquamarine, emerald, and hiddenite. There are numerous veins near the mine which carry common beryl, aquamarine, and quartz, but emeralds and hiddenite were found in only a few veins. Hiddenite, the emerald-green spodumene, was the chief mineral of value obtained from this locality, though some fine emerald crystals were found.

According to Arthur Keith,[2] at the Crabtree Mountain locality in Mitchell County, N. C., the emeralds occur in pegmatite inclosed in mica gneiss. A few feet east of the vein is a body of hornblende gneiss. The pegmatite has a northerly strike and dips 45°–50° E. It is composed mainly of feldspar, quartz, black tourmaline, and beryl, and incloses horses of biotite-tourmaline schist. The emeralds occur

[1] Precious stones (translation by L. J. Spencer), Charles Griffin & Co., Ltd., London, 1904.
[2] Mount Mitchell folio (No. 124), Geol. Atlas U. S., U. S. Geol. Survey, 1905.

sparingly through the pegmatite but are more plentiful in the upper 8 inches under the hanging wall where many are in small bunches and horses of schist. The gems are "frozen" in the pegmatite. Small crystals of emerald are abundant, and the color of many of them is good emerald-green. Some are pale colored or yellowish. Occasional gems of value have been found. Much of the pegmatite matrix containing white feldspar, gray quartz, black tourmaline, and green emeralds, has been cut under the name of emerald matrix. Some of this materail is very pretty.

The occurrence of emeralds at the Turner mine is similar in many respects to that at some other localities, but there are here certain associated rocks which seem to belong naturally with the occurrence of emeralds that are not present in other deposits.

The rocks of this portion of the Piedmont Plateau are principally gneisses and schists of Archean age, cut by masses of later granite, diorite, and other rocks. In the region around the emerald prospect the types of rock are varied. There are mica, garnet, cyanite, graphite, and hornblende gneisses and schists cut by granite, pegmatite, diorite, gabbro, and other ferromagnesian rocks. Another rock which answers the description of garnetiferous quartz diorite occurs abundantly at certain horizons in the gneiss. The strike of the rock formations is variable between east-west and north-south where the strata are tilted, but over large areas they are essentially flat with many small rather gentle folds.

Warping of the rocks with larger sharp folds occurs and produces abrupt changes in outcrop, so that mapping the formations is difficult. Another difficulty is the apparent metamorphism of ferromagnesian rocks to rocks of less basic composition, and of granite to more basic composition by reaction between the two at the time of the intrusion of the granite. In the descriptions of the rocks associated with the emerald deposit in these reports for 1909 and 1910, tentative names were given to some rocks, as the material available for examination was so badly weathered. Less altered specimens obtained from greater depth have made more accurate determinations possible. Thus, rock called amphibolite, and amphibolite after pyroxenite, proves to be hornblende hypersthenite and is so called below. A number of varieties of basic rocks occur, but all may be placed in one general class.

The most common type is hornblende hypersthenite-peridotite, and of this there are numerous outcrops. In some occurrences olivine is lacking or scarce, and the rock may be called hornblende hypersthenite. The minerals composing these rocks, as determined by microscopic examination, are pale-green hornblende, light-brownish hypersthene, olivine, augite, biotite, pleonaste, magnetite, and a little sulphide. Hornblende and hypersthene are present in all occurrences, but one or all of olivine, augite, biotite, and pleonaste were not observed in some specimens. The hypersthene and olivine occur in poikilitic crystals, in some specimens of large size. In some places weathering has changed hypersthene to bastite, hornblende to chlorite, and added limonite stains. The result is a rock resembling chloritic soapstone. On disintegration and decomposition these rocks break down to a dark greenish-brown lumpy soil.

Gabbro occurs at several localities and is of two kinds, common and olivine gabbro. The former exhibits a partial diabasic texture in thin

section. The constituent minerals determined microscopically in one specimen are labradorite, hornblende, part original and part formed from pyroxene, augite, hypersthene, biotite, magnetite, apatite, and pyrrhotite. Olivine gabbro is associated with the hornblende hypersthenite-peridotite, and the two rocks are probably segregations from the same magma. Some specimens contain such minerals as to make it difficult to determine whether the rock should be called olivine gabbro or hornblende hypersthenite-peridotite. The olivine gabbro weathers to a soil very similar to that formed by the peridotite. Spheroidal bowlders are generally left over in the outcrops.

Diorite and hornblende gneiss are common rocks of the region. Microscopic examination of sections reveal hornblende, andesine, biotite, iron ore, apatite, zircon, and, in some specimens, quartz. On weathering the dioritic rocks form dark-brown clay soils.

The granite of this region is medium-grained biotite granite. Pegmatitic phases are associated with it, especially near the contact with other rocks, and in some places the small bodies may equally be called pegmatite or granite. On disintegration the granite breaks down to a light sandy soil.

The relations between the granite and the basic rocks are interesting. Besides the types of basic rocks mentioned, there are gradations from them into granite by the presence of granite minerals. This gradation is present where gabbro, olivine gabbro, and hypersthenite-peridotite are inclosed in granite. Thus, a specimen from a spheroidal bowlder of weathering near a gabbro and granite contact contained andesine or labradorite, hornblende after pyroxene, biotite, and considerable quartz along with iron ore, apatite, and pyrrhotite. The true gabbro from this body has more calcic feldspar and ferromagnesian minerals with no quartz. A spheroidal bowlder from a similar contact at the emerald mine contained hornblende, biotite, labradorite, quartz, magnetite, and apatite. Diorite contacts with granite show a similar gradation by the presence of quartz.

The ages of all the different rocks have not been determined. The mica and garnet gneisses and schists are of Archean age and belong to the Carolina gneiss, as designated by Keith in the geologic folios on the southern Appalachian region. The diorite and associated hornblende gneiss and schist are also Archean and belong to the Roan gneiss. The gabbro, olivine gabbro, and hornblende hypersthenite-peridotite rocks are probably of later age. They were intruded into the other gneisses and schist before the granite, and Keith thinks much of the granite of this region is probably of post-Carboniferous age. The intrusion of the granite before the complete consolidation of the basic rock magmas would make easier an explanation of the apparent mutual absorption described above that has taken place between the two. If the basic rocks are considered much older than the granite, the reaction between the two and absorption by the granite appear to offer a better explanation than would be offered by magmatic differentiation.

Pegmatite probably representing later stages of activity of the granite magmas have filled openings and fissures in the rocks. Some of these are in the basic rocks, and it is in such fillings that the emeralds have been found on the Turner place. Several pegmatite veins have been uncovered during the prospecting, but so far emeralds

have been found in only one of them. The basic rocks are olivine gabbro and hornblende hypersthenite, with transitional phases between them. Diorite lies to the west of these, and all have been surrounded and intruded by biotite granite.

The emerald-bearing vein has an irregular strike approximating east and west with a high dip north. It is medium to coarse grained, and is composed of quartz and feldspar, part of which, at least, is albite, with some black tourmaline sprinkled through it and an occasional emerald or green beryl crystal. The crystallization of the minerals of the pegmatite is not good, but a few partly developed crystals are found in small, irregular miarolitic cavities. Crystals found in these cavities are quartz (colorless and smoky), albite, feldspar, black tourmaline, and a little beryl. The cavities in the pegmatite are partly filled with reddish-brown, greasy-feeling clay, and the same material along with limonite stains has permeated joints and seams through the pegmatite. The feldspar of the pegmatite has partly decomposed in places, so that the rock breaks down rather easily. Some of the emerald crystals are firmly attached to other minerals, and some are loose and may be obtained by washing the semidecomposed pegmatite. At first many small fragments and crystals of emeralds were found in this way, but later gem emerald was also found in place in the rock.

The crystallization of the quartz and feldspar so far found in the pegmatite vein is not so perfect as that in the veins once worked for beryl and hiddenite at Hiddenite, N. C. The albite assumes the form of rough crystals and of aggregations of stout crystals, though not of the cleveländite type common in many gem-bearing pegmatites. The quartz occurs in crystals of average perfection, and in many of the specimens exhibits trapezohedral faces indicating a right-hand character. Some of the quartz is nearly colorless and other is smoky. One crystal of quartz examined is penetrated by numerous fine light-colored needles of actinolite. The emerald crystals are simple hexagonal crystals of beryl with the prism faces and base. Many of them are deeply striated and etched, especially on the prism faces. Other crystals have internal striations or irregularly shaped tubes extending through their length. Some of these tubes are of considerable size compared with the crystal inclosing them and have been filled with clay or iron stains. The finer tubes appear as silky striations in the crystals.

Veins containing quartz crystals occur in the same formation as the emerald-bearing pegmatite. Some of the quartz crystals from these veins are fairly well developed and clear; others contain inclusions of fine needles of actinolite and cut into very pretty gems. Veins of quartz crystals occur over a large area in this region and yield some fine specimens. Large crystals containing liquid with bubbles have been found about a mile northwest of the emerald mine in a similar rock formation. Black tourmaline is plentiful both at the emerald mine and in other places.

Determinations of chromium oxide were made in four rocks from the emerald region by R. C. Wells, of the United States Geological Survey. Hornblende hypersthenite wall rock for the emerald vein carried 0.16 per cent Cr_2O_3; olivine gabbro, also close to the emerald vein, contained 0.17 per cent Cr_2O_3; hornblende-hypersthene-augite

peridotite from about three-fourths of a mile east of north of the emerald mine carried 0.19 per cent Cr_2O_3; and diorite from near the emerald mine carried 0.04 per cent Cr_2O_3.

Pale-greenish, yellowish, and gray beryl crystals have been found in pegmatite cutting granite and mica schist and gneiss in this region, but the only emerald deposit discovered is where such pegmatite cuts a chromium-bearing rock. This association of emerald-bearing pegmatite with a chromiferous basic rock seems a most natural one. A theory of origin of the emeralds at the Turner mine may be thus briefly stated:

Chromium-bearing basic rock was intruded by granite magma either before or after final solidification of the basic rock. There was a partial absorption of the latter by the granite magma and some of the constituents of the basic rock were taken into solution. Pegmatite veins, in which distinct crystals were only partly developed, formed during the cooling of the rocks. The elements necessary for the formation of beryl were present in the magmatic solutions producing pegmatite, as in some other places in the region. Chromium oxide necessary to impart a color to the emerald was obtained by the action of solutions on the basic rock. A curious coincidence is the fact that the per cent of Cr_2O_3 in the basic rocks at the Turner mine is about the same as that found in emerald from Colombia, by T. Wöhler, as mentioned above.

Should the theory of origin outlined above be essentially correct, prospecting in areas where similar rock associations occur might locate other deposits of emeralds. Of course, it should not be expected that every pegmatite associated with the rocks mentioned will carry emerald, for beryl has been found with only a very small proportion of the large number of pegmatites occurring in the region. Besides chromium-bearing basic rock and pegmatite, the presence of the elements of beryl in the original pegmatite-producing solutions would be necessary. Outcrops of basic rocks similar to those at the Turner mine occur in a number of localities in the region south of Shelby, and some of these are near if not associated with granite. Pegmatites cut many of these basic rock masses, and over some of the outcrops crystals of black tourmaline, quartz, and quartz-inclosing actinolite are plentiful as at the Turner mine. In some of these areas the associations are very similar to the emerald locality. The occurrence of the basic rocks is not always easily recognized, since weathering has been extensive. In such places a study of the soil will often give the clue desired.

GARNET.

NEW HAMPSHIRE.

The occurrence of a quantity of deep-red garnets on a hill near Chesham, in Cheshire County, is reported by Mr. Leon Allen, of Keene, N. H. The garnets are small but would yield clear gems ranging from one-eighth to one-half of a carat. Further prospecting will be carried on during 1912.

COLORADO.

The discovery of small bright-yellow grossularite garnets is reported by Mr. J. D. Endicott, of Canon City, Colo., in the basin of North

Fork of Arkansas River. These garnets occur in cavities in altered granitic rock and make good specimens. They are of gem quality, but too small for cutting. Mr. Endicott also obtained a quantity of specimens of spessartite garnet from the "Ruby Mountain" locality across Arkansas River from Nathrop. These garnets occur in cavities in rhyolite associated with topaz and other minerals. The topaz also occurs in good crystals and makes fine specimens.

JASPER.

MONTANA.

Specimens of Montana jasper have been furnished by Mr. J. H. Mosher, of Glendive. One variety is composed of dark-yellow jasper, in which are turtle-back markings of gray chalcedony and a little metallic hematite with a few patches of bright-red jasper scattered through the specimen and in a broad band along one side of it. The pattern and colors displayed by a gem cut from this material are very pretty. Another variety which Mr. Mosher calls mahogany jasper has a dark-reddish mahogany color with peculiar patches and irregular streaks of darker color resembling the grain of wood.

CALIFORNIA.

The spherulitic jasper-like quartz from the San Francisco region described in this report for 1910 is being cut with good results. The trade name "kinradite" was proposed in acknowledgment of Mr. J. J. Kinrade's part in bringing this unique gem before the public. There is considerable variation in color and size of markings in different specimens, but the beautiful radial structure of the red spherulites is visible in most gems. Probably the most common type of stone consists of bright-red spherulites in dark-greenish and reddish-brown matrix. An attractive stone is cut from material in which the red spherulites are scattered through an ocher-yellow matrix. Mr. Kinrade says the best specimens are found between Point Bonita and Fort Baker in the southern end of Marin County. Another locality is near Lands End station about 1 mile northeast of the Cliff House in San Francisco County. "Kinradite" is also found at other places along the coast of California as far north as the Oregon line.

Bloodstone.—Specimens of bloodstone and notes on the occurrence have been furnished by Mr. F. M. Myrick, of Randsburg, Cal., from a new locality discovered by him in San Bernardino County. The stones were found on Brown Mountain in the Death Valley region, about 15 miles north of the St. Stephen stone locality mentioned above. Several pits have been made, the largest of which is 15 feet long, 10 feet wide, and 12 feet deep. The bloodstones are found in a claylike formation in "malpaís" over an area 800 feet long and 200 feet wide. They occur in bunches or pockets containing from a few pounds to more than 30 pounds. The color and quality of the bloodstone found at the surface are as good as those from a depth of 12 feet. Several hundred pounds of rough stone have been mined and a quantity of select material placed on the market.

The mineral is true bloodstone or heliotrope composed of slightly translucent dark leek-green plasma through which bright blood-red

and yellowish-red spots, patches, and streaks occur. Some of the plasma has a uniform color and texture over considerable areas, and some contains a few patches and streaks of chalcedony and finely crystallized quartz. A few of the red spots are rounded like drops of blood, but most of the red is in large or small irregular patches and streaks. The different patterns formed in the latter case furnish pretty gem material, but the most valued specimens are those in which the red spots are nearly uniform in size and distribution through the green. Cut gems of this bloodstone have been well received in the Southwest and some of them have brought good prices.

LAZULITE.

CALIFORNIA.

The writer is indebted to Prof. G. Montague Butler, of the Colorado School of Mines, for two gems cut from lazulite matrix from California. The rough material was obtained from Breyfogle Canyon, in Death Valley, by W. B. Patrick, a former student of Prof. Butler's. The lazulite occurs in a vein cutting schist. The vein varies from 1 inch to 5 feet in thickness and can be traced several miles. The lazulite is confined to a comparatively few patches in the vein. Pure blue gems can be cut from some of the lazulite, but Prof. Butler states that they are not as pretty or attractive as those containing matrix. The matrix is chiefly white quartz with occasional brownish patches and seams. In the specimens examined the lazulite varies from pale azure blue to fairly deep azure blue. In one specimen it occurs in both small crystals and crystal aggregates through the white quartz. In the other specimen there is a large crystal or crystal aggregate with less quartz. These gems are unusual and pretty and are said to be very attractive mounted in silver.

OPAL.

NEVADA.

Further information regarding the opal deposits in Humboldt County, Nev., mentioned in this report for 1909, has been given by Mr. Ivan Dow, of Nevada City, Cal. The deposits are on the Miller & Lux ranch, managed by H. E. Rinehart, about 20 miles south of the Oregon State line and 40 miles east of the California State line. Ivan Dow and George D. Matthewson, of Delta, Utah, own an interest in the opal deposits and have been encouraged by finding some fine gem material. Prospecting will be continued during 1912. The precious opal occurs in part as petrifactions of wood and limbs of trees. In such specimens the texture of the wood has not been preserved, but the outline remains with the bark of branches of a slightly different color from the interior. The opal has been declared of fine quality by dealers. Gems of excellent quality obtained from this locality have been seen by the writer.

MEXICO.

A description of a Mexican opal mine was given by T. M. M. MacFarlane in a paper read before the Instituto mexicano de minas y metalurgía, August 7, 1911, of which the following is an abstract:[1]

[1] Taken from abstract in Eng. and Min. Jour., Oct. 28, 1911, p. 842.

The principal producing opal mines of Mexico are at present in the State of Queretaro, though fine stones have come from Zimapan, Hidalgo. The mine examined is near the top of a range of hills composed of reddish-gray spherulitic rhyolite. The mine was opened in this rock some six years ago at a point where opals had been exposed by weathering. The opal is obtained by quarrying and later breaking up the blocks into 2-inch cubes or less. The face of the quarry is about 40 feet high of which the lower 25 feet is productive. The upper 15 feet of rhyolite is decomposed and carries no opals. It is stripped to the opal-bearing layer and the latter is quarried. Gunpowder is used in blasting the barren rhyolite, but dynamite is necessary in the hard opal-bearing rock. The limit of depth to which opal will be found is not known, but other mines are reported to be producing opal at a depth of 100 feet.

Surface indications for opal called "pintas" consist of a white siliceous sinter filling cavities in the rhyolite. These are considered infallible but furnish no information as to the quality or quantity of opal to be expected. A corroded appearance on the working faces and numerous cavities containing deposits of silica are common in the quarry. Many of the cavities are lined with clear brittle quartz and contain loose deposits of opal. In other cases opal fills the entire spaces in which it occurs, and is intimately joined to the rock either with or without surrounding iron stain. Opal of good quality is found in both occurrences.

About once a week the rough opal is taken to Queretaro for polishing. The stones are first roughly shaped on ordinary large grindstones into the largest sizes consistent with symmetry and beauty. The roughly cut gems are then smoothed on a sandpapering machine and given a final polish on soft rough leather.

QUARTZ.

OHIO.

Occasional clear colorless pebbles are found in the gravel beds in the vicinity of Windsor, Ohio, and a few have been cut for gems. Several small rough specimens and a cut gem were received from Mr. S. Stoughton, of Windsor, for identification. They proved to be transparent quartz pebbles of sufficiently good quality for cutting where such material is desired.

ROSE QUARTZ.

VARIOUS LOCALITIES.

Rose quartz occurs at many localities in the United States, and varying quantities from a number of these have been cut for gems and ornamental purposes. The principal output has come from the Red Rose mine of Samuel Scott, 6½ miles S. 50° E. of Custer, S. Dak. This mine was described in this report for 1908. Other deposits of rose quartz occur in the Black Hills of South Dakota, but so far none have yielded good dark gem material. Rose quartz has been found at several places in Colorado, and promising material occurs in the Wild Rose claim of J. D. Endicott, 6 miles north of Texas Creek, Colo. Deep rich pink rose quartz has been found in Maine, but much

of the mineral from that State is rather pale colored. Rose quartz of varying quality has been found in Connecticut and New York. Several deposits have been located in California in widely separated areas; among these are the Parson claim, described below, several deposits near Lemon Cove and Badger, in Tulare and Fresno counties, in Hemet Valley, Riverside County, and in San Diego County.

CALIFORNIA.

The Summer Rose quartz claim of W. D. and George W. Parson is about 8 miles south of east of California Hot Springs, probably in Tulare County near the Kern County line. It is on the west side of Bull Run Ridge in the roughly dissected plateau-like country east of the first high ridge of the Sierra Nevada, a few miles west of Kern River. The elevation at the mine, determined barometrically, is about 7,000 feet above sea level, or nearly 4,000 feet higher than California Hot Springs. The region around the prospect is well timbered with pines, spruce, fir, and arbor vitæ.

The rose quartz ledge was discovered some 15 years ago by George W. Parson, but little attention was paid to it until 1908, when specimens were taken and submitted to dealers. The Summer Rose claim was located in October, 1910. Only assessment work has been done at the prospect, consisting of openings in the hard rock in search of gem material. Much care is required in this process in order that valuable mineral may not be destroyed.

The country over a large area surrounding the prospect is granitic in nature and in the field might be called hornblende-biotite granite. A specimen from adjoining the rose quartz deposit, examined under the microscope, contained andesine and a little orthoclase feldspar, dark-brown biotite, dark-green hornblende, considerable quartz, a little iron ore, and apatite. Such a rock is intermediate between monzonite and quartz diorite, and here might be called coarse quartz diorite. It has disintegrated to a gravelly sandy soil, through which occur spheroidal bowlders of harder rock. The rose quartz outcrops on the steep slope near the crest of a ridge. It is associated with fine graphic granite in a mass of pegmatite. The quartz mass stands about 25 feet above the outcrop on the lower side and is but little higher than the surface of the ground on the upper side. The width exposed between the base of the outcrop and the contact with graphic granite at the top is about 35 feet, but the true thickness could not be determined. About 80 feet of the quartz is exposed in a direction N. 10° W. It is probable the ledge strikes west of north and dips to the west about with the slope of the hill. At the south end of the outcrop the quartz ledge is covered by soil and brush, and at the north it ends rather abruptly on the hillside.

The quartz has been broken by joints into columns and blocks ranging from over 1 foot thick to sheets as thin as one-sixteenth of an inch. Some of it has been crushed into coarse granular masses. Part of the quartz is white, but most of it is rose colored. In places patches of dark rose quartz occur in white or pale colored material. In the same way translucent and nearly clear rose quartz are inclosed in opaque quartz. The gem mineral ranges in color from nearly colorless to very pale delicate pink to deep pink, and some of it has a magenta tint. Much of it is translucent and somewhat opalescent, and

some is nearly clear. The several varieties would serve for gems as beads, cabochon-cut stones, and faceted stones. Practically flawless specimens an inch thick and larger pieces with small seams or feathers can be obtained. The perfect specimens are obtained by breaking up coarsely crushed masses of rose quartz, from which they fall out as the fracture or rift planes are exposed. Beautiful rose quartz can be obtained from this prospect, and some of it has brought good prices when retailed in California.

J. A. Edman, of Quincy, Cal., reports the occurrence of pale rose quartz in quartzose schist near Johnsons Bar on the north fork of Feather River, in Plumas County. This rose quartz could probably be obtained in large quantity. Deposits of rose quartz have been found by George D. Ward about 9 miles north of Lemon Cove, near Thomas Homer's ranch, and by Edward Hill near Badger. Specimens with a very good color were seen from the Ward prospect.

RHODONITE.

CALIFORNIA.

Massive, finely granular rhodonite occurs at many localities in California, and some of them have yielded gem and ornamental material. The different deposits yield a similar product, the chief difference being in richness of color. Black manganese oxides are associated with much of the rhodonite, filling seams and cracks, and make pretty contrasts with the pink. Probably the best gem material so far found has come from the Wheeler prospect, about 9 miles north of Happy Camp, in Siskiyou County, but good material has been found near Taylorsville, in Plumas County, and other localities. These rhodonite deposits are associated with sedimentary rocks and occur along belts of manganese-stained slates and quartzites.

A rhodonite deposit on one of these manganese leads has been found on the land of L. F. and George D. Ward, about 3 miles north of Lemoncove, Tulare County. The outcrop examined is on the north side of a draw about one-third of a mile northeast of Kaweah River, and about 1 mile east of Ward's ranch house. The hills at this place are from 300 to 500 feet above the stream beds, and are partly covered with rock outcrops and partly with soil and vegetation. The rocks lying west of the rhodonite are consecutively heavy beds of quartzite, granite and mica schist, slates, and black and white mottled marble. All of these formations, including the manganese bed, are steeply tilted. The rhodonite occurs in two ledges about 35 feet apart, with quartzite between. The ledges form outcrops several feet high and strike about N. 35° W. and dip about 60° NE. The southwest ledge is about 10 feet thick; the northeast ledge is nearly 30 feet thick, but less solid, and contains much quartzite stained with black manganese oxides. The latter is so plentiful in places that it might be of value as an ore of manganese. The rocks, including the rhodonite deposits, have been broken into coarse blocks and contain numerous seams filled with black manganese oxides. Rhodonite could be obtained rather plentifully, but would require considerable hand cobbing to secure the better grades for ornamental purposes. Rhodonite of several shades of color occur, and these are intermixed in some specimens. The rhodonite has a delicate light to dark rose color, but the

majority is rather inclined to grayish pink, and some is greenish gray. Both finely granular and rather coarsely crystallized rhodonite occur. The different colors and textures grade into each other and with the black seams and markings would yield contrasting ornamental material. The purer pink varieties, with or without the black seams, could be cut into very pretty gems.

OREGON.

Specimens of rhodonite with information on the occurrence have been received from Mr. C. H. Gillette, of Ashland, Oreg., from a deposit near the Josephine County caves. The rhodonite is associated with black oxides of manganese below a limestone formation. The specimens sent were obtained during prospecting for manganese and had been badly fractured during blasting. The rhodonite is delicate rose pink, and with it is associated gray and a little greenish-gray mineral, also probably rhodonite, and manganese oxides. The texture is very fine grained, nearly compact, so that the material ought to take a good polish. The combination of colors would yield pleasing gems.

SAPPHIRE.

MONTANA.

A large production of sapphires was reported from Montana during 1911. The output came from the Yogo blue sapphire mines in Fergus County; Rock Creek, in Granite County; Dry Cottonwood Creek, in Deerlodge County; and the Missouri River placers east of Helena. The mines operating in Fergus County were the New Mine Sapphire Syndicate and the Yogo American Sapphire Co. These companies obtain sapphires by mining, disintegrating, and washing a rock matrix. The sapphires obtained here are nearly all blue; those from the other localities are varicolored, and fine blue stones are rare. The Yogo American Sapphire Co. commenced operations in July, 1909, but as no report was received by the Survey the output of this company was not included in the tables of production for the years 1909 and 1910. Mr. H. O. Chowen, president of the company, has supplied statistics of production for the last three years, and this total output is given combined with that of other producers for 1911 in the subsequent table. Consequently the figures given for 1911 are a little high, but the great increase over 1910 is also in a large part due to increased productions from other mines.

The output of the New Mine Sapphire Syndicate was also greater than in 1910. Some fine sapphires are reported to have been found at this mine in 1911, two of which were exceptionally good. One of these weighed 3½ carats and the other 2½ carats and both had a beautiful cornflower-blue color. The summer season, in which the washing is done, was better than in 1910, and no cloudbursts occurred to damage the ditch on which water for washing is dependent. The water supply was plentiful and together with the new depositing floors laid down in the previous summer added to the increased production of gems.

The sapphires mined from the other localities mentioned all occur in placer gravel deposits. On Dry Cottonwood Creek some have been mined by dredging, and one dredge was operated by the Consoli-

dated Gold & Sapphire Mining Co., of Butte, in 1911. The American Gem Mining Syndicate works its placers in Granite County by hydraulics and sluicing The few sapphires obtained from deposits of Missouri River were found during gold placer mining.

The production of sapphires in 1911, including those mined by the Yogo American Sapphire Co. in 1909 and 1910, amounted to about 88,477 ounces, of which probably about 86,000 ounces were culls for watch jewels, meter bearings, and other mechanical purposes. There were nearly 384,000 carats of varicolored sapphires of suitable size and quality for gems. The total valuation, in part estimated, placed on the production is $215,313.

TOURMALINE.

CALIFORNIA.

Very li tle tourmaline was mined in California during 1911. The larger mines were closed, and only a small scattered production was reported to the Survey. Apparently the large output of previous years more than supplied the demand, so that sales were made from gems in stock. H. E. Dougherty, of Hemet, Cal., states that the demand for pink cabochon gem material by Chinese merchants also fell off greatly, and only the largest deep-pink crystals were bought.

MAINE.

Development of the mine near Poland was continued by F. L. Havey, of Lewiston, during 1911. More pockets of tourmaline were opened, and fine white and pale to dark green crystals were found. Many of these would cut into clear brilliant gems. Mr. Havey's tourmaline deposit was discovered in 1910 during the operation of a feldspar quarry, a full description of which has been given by E. S. Bastin.[1] Prior to this, occasional gem tourmalines were found during the feldspar quarrying.

TURQUOISE.

GENERAL CONDITIONS.

Turquoise has been mined in large quantities in the Southwestern States of the United States. Deposits have been worked in New Mexico, Arizona, California, Nevada, and Colorado, and on a small scale in Texas. At a number of these deposits there were remains of ancient workings, pits, shafts, tunnels, and stopes, with dumps of waste rock, made by Indians or other early inhabitants of the Southwest. Some of the deposits were operated under Spanish rule. At most of the ancient workings, stone hammers and axes, pottery, etc., have been found. That turquoise was used by the early inhabitants of this region is shown by the finding of beads and ornaments in the cliff-dwelling and other ruins. The early Spanish explorers found turquoise among the gems highly valued by the Mexicans, who called it chalchihuitl, probably including other minerals under the same name. To the present day the Indians of the Southwest prize turquoise jewelry and sometimes buy the gem lavishly. A

[1] Geology of the pegmatites and associated rocks of Maine: Bull. U. S. Geol. Survey No. 445, 1911, p. 58.

Navajo Indian sheep herder was seen to buy $125 worth of turquoise in a few minutes' time at a trading store after disposing of some $300 or $400 worth of wool to the trader. It is said that the Indians still obtain turquoise either from localities known only to themselves or from well-known mines either not now in operation or under guard.

Many of the turquoise deposits of the Southwest have been worked intermittently and on a rather small scale. A few, however, have been extensively developed, and some have been operated continuously for a period of years. During some years large outputs have come from a few mines, and in other years many deposits have contributed to the production. In recent years turquoise matrix has been in demand, and large quantities have been mined, resulting in an overproduction. Consequently the demand is at present limited and many mines are closed down. In 1909 over 17 tons of turquoise matrix and turquoise were produced, in 1910 nearly 8½ tons, and in 1911 a little over 2 tons. In 1909 the production came from Mineral Park, Ariz., Cottonwood, San Bernardino County, Cal.; La Jara, Colo.; Esmeralda, Nye, Lincoln, and Lyon counties, Nev.; Cerrillos, Little Burro Mountains, and Hachita, N. Mex. In 1911, turquoise was produced only in the Little Burro Mountains and Cerrillos regions, N. Mex.; Mineral Park, Ariz.; and Esmeralda County, Nev. Of the total production of turquoise and turquoise matrix in 1911 probably not over 10 to 15 pounds was the best selected pure blue gem.

NEW MEXICO.

There are two groups of turquoise deposits in the Cerrillos region—one around Mount Chalchihuitl, 2½ miles east of north of Cerrillos, and the other in Turquoise Hill, about 6 miles east of north of Cerrillos. Mount Chalchihuitl is a small hill lying to the south of east of Grand Central Mountain, of which it may be considered a foothill. It rises some 200 feet above the valleys on its east and west, with moderately steep slopes broken here and there by excavations. Openings for turquoise have been made on the summit and on the northwest, the southeast, the west, and the south sides of Mount Chalchihuitl. Turquoise has been found at several other localities in the neighborhood, and among these are the mines of Michael O'Neil, about three-fourths of a mile southeast of Mount Chalchihuitl, and of A. B. Renehan, about half a mile west of north of Mount Chalchihuitl. Ancient workings were found around each of these deposits and, in most of them, exceed in amount the work done in recent times.

The workings on Mount Chalchihuitl are historic and there are evidences that the deposits were operated both by Indians or other ancient people and under Spanish rule. Rather extended prospecting in modern times failed to discover any large deposits of good turquoise. In a paper "on the Chalchihuitl of the Mexicans"[1] Blake describes the extent and apparent age of the workings on Mount Chalchichuitl and the occurrence of the turquoise. The principal ancient working is described as:

> An immense pit with precipitous sides of angular rock projecting in crags, which sustain a growth of pines and shrubs in the fissures. On one side the rocks tower

[1] Blake, W. P., Am. Jour. Sci., 2d ser., vol. 25, 1858, pp. 227-232.

into a precipice and overhang so as to form a cave; at another place the side is low and formed of the broken rocks which were removed. * * * The bottom is funnel-shaped and formed by the sloping banks of the débris or fragments of the sides. On this débris, at the bottom of the pit, pine trees over a hundred years old are now growing, and the bank of the refuse is similarly covered with trees.

A review of the early history of Mexico and this region with references to the authors is given, and in this the identity of chalchihuitl with turquoise and the esteem in which it was held by the ancient Mexicans is brought out. The use of turquoise by the Mexicans before the advent of the Spanish, the operation of the mine under Spanish rule ending in an uprising of the Indians when a fall of rock buried some of their number, the presence of broken ancient Indian pottery, and the condition of the workings are given as evidence to show that the excavations are of great age.

A description of the same locality by Silliman [1] confirms Blake's observations and gives notes on the prospecting in progress by D. C Hyde in 1880. Further information on the discoveries made by Mr. Hyde is given by Kunz.[2] This prospecting consisted of shafts sunk in the bottom of the main pit, on the summit of the hill, and on the southeast side, with tunnels from them. Cavern-like excavations were found on each side of the "mountain" and were named by the prospectors "Wonder caves" and the "Mystery." In these workings, according to Silliman, "were numerous stone hammers, some to be held in the hand and others swung as sledges, fashioned with wedge-shaped edges and a groove for a handle." One of these stone hammers weighed a number of pounds and had the wythe and scrub-oak handle still attached. Kunz states that numerous veins of turquoise one-eighth inch to 2 inches thick were found in one of the caves. D. W. Johnson [3] reviews the literature on the locality and discusses the occurrence and origin of the turquoise.

It is evident that the condition of the workings have changed little since the descriptions of Blake, Silliman, and Johnson. A few measurements and estimates made in 1911 show the main pit on the northwest side of the hill to be about 130 feet deep on the upper side and about 35 feet deep on the lower side, the rim about 200 feet across, and the bottom nearly 100 feet across. The large dumps of waste rock removed from this are about 150 yards long by 75 yards wide and 1 to 30 feet deep. These dimensions do not correspond closely with those given by the earlier writers, since this would give the dump an area of less than 2½ acres as compared with some 20 acres reported by Silliman. The upper walls of the pit are still rough with projecting rocks and the lower slopes are covered with talus. The exploratory work done by Mr. Hyde has been concealed by caving or other agencies. The workings on the other parts of Mount Chalchihuitl are less extensive. On the southeast side is an open cut over 100 feet across, with a present depth of 20 feet on the upper wall.

Little can now be seen of the occurrence of the turquoise at Mount Chalchihuitl, but published descriptions show it to be similar to that of other localities described below. The associated rock with its fracturing and alteration and the mode of occurrence of the turquoise at the different localities are very much alike.

[1] Silliman B., Turquoise of New Mexico: Am. Jour. Sci., 3d ser., vol. 22, 1881, pp. 67–71.
[2] Kunz, G. F., Gems and precious stones, New York, 1892.
[3] Johnson, D. W., Geology of the Cerrillos Hills: School of Mines Quart., vol. 24, 1903, pp. 493–499; vol. 25, 1903.

A few notes on the geology of the region are given before the deposits are described.

Johnson[1] describes the Cerrillos Hills as remnants of laccolithic intrusions into Cretaceous strata. The sedimentary strata covering the intrusions have been eroded away, and the present hills are the more resistant portions of the igneous rocks. The principal rocks are described as augite andesite, hornblende andesite, and mica andesite. Augite andesite is mapped as most abundant and with hornblende andesite forms the matrix for the turquoise. Lindgren[2] in discussing the same rocks points to the fact that orthoclase is present in many of them and that the texture is decidedly holocrystalline and porphyritic. Such rocks belong in the monzonite group.

Examination of thin sections of rock from several places in the areas mapped as augite andesite by Johnson confirms Lindgren's determination. Alteration has made difficult the identification of the feldspars in many sections. In some the striations of plagioclase are largely concealed by secondary minerals and add uncertainty to the determination of altered orthoclase present in the same sections. Locally the texture of the monzonites is so fine grained that they might be called latite, of which andesite is a variety. A specimen from an area mapped as hornblende andesite had a porphyritic texture and was composed of such minerals as are characteristic of diorite or andesite.

The rocks have been strongly fractured, especially in those areas where turquoise is now found. Both large and small fissures were formed, and numerous minor joints cutting the rock in all directions. The rocks have been considerably altered in many places, and around the turquoise-bearing areas alteration has been extensive. Alteration was favored by the easy channels open to solutions in the badly fractured areas. The process outlined by Lindgren offers a good explanation of the present associations at the turquoise deposits. The original monzonite porphyry was greatly altered by mineralizing solutions in fracture zones and abundant secondary sericite developed. Later weathering by surface waters produced kaolin and other hydrous minerals characteristic of the oxidized zone and among them turquoise.

In describing the occurrence at Mount Chalchihuitl, Johnson[1] says.

> The rock is yellow or white in color, sometimes mottled or streaked with iron stains. * * * The turquoise occurs as seams throughout the rock, filling crevices formed by crushing and shearing, and as little nodules in streaks or patches of kaolin. The color varies from green through greenish-blue to pure sky-blue. Many of the specimens are marred by streaks of limonite, kaolin, etc.

Practically all the rock on Mount Chalchihuitl is altered. The general appearance is white to gray and yellow, but some is stained brown and purplish in small masses. Most of it has a somewhat porous earthy texture but is not broken with a hammer as easily as its appearance would lead one to expect.

At Michael O'Neil's turquoise mine turquoise has been found over a distance of about 300 yards in a direction N. 30° W. Ancient workings and prospecting for silver have left numerous openings along this

[1] Johnson, D. W., Geology of the Cerrillos Hills: School of Mines Quart., vol. 24, 1902-3, pp. 456-477.
[2] Lindgren, Waldemar, The ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910, pp. 165-166.

turquoise lead, so that without the aid of a guide it was difficult to determine at what places turquoise had been found. About a dozen shafts and a large number of prospect pits and cuts had been made over a belt of country about 250 feet wide. Some of the shafts were 40 to 50 feet deep and around them were open cuts. At one of these a track for a mine car had been laid through the cut to a platform over the shaft to expedite the removal of rock. The turquoise is associated with decomposed rock quite similar in appearance to that on Mount Chalchihuitl. The rock is porous white to gray, and part is stained with iron oxides. Less altered phases are gray or drab, and some that has suffered little weathering is dark speckled gray. The turquoise occurs in seams, veinlets, and segregations, as in the other deposits of this region. Some good pure blue gem has been found as well as considerable good matrix associated with brown limonite iron stains. Turquoise has been worked intermittently at this mine during the last few years, but little was done in 1911. Oxidized copper ores were found in the workings of the north end of the O'Neil mine.

At A. B. Renehan's claim several pits, shafts, and open cuts had been made. Some of these were in part ancient workings. The latest work consists of an open cut about 75 feet long, 3 feet to 25 feet deep, and 6 feet wide. The rock formation is quite similar to that around Mount Chalchihuitl. The badly decomposed rock is nearly white and porous and less altered phases are bluish-gray. Turquoise is found in seams and veinlets in the decomposed rock. Some very good blue turquoise is reported to have been found. The claim was worked in a small way during 1911, but no turquoise was sold.

Turquoise Hill is a low elbow-shaped ridge rising from 100 to 300 feet above the plains northeast of the Cerrillos Hills. It has four summits—a main summit and others, about 250 yards S. 25° E., about 300 yards west, and about 500 yards S. 75° W., respectively. The elevation of the main hill is about 6,400 feet above sea level. The hills are well rounded and slope gradually into the plains. Rock outcrops are not prominent, but the surface is covered with angular blocks and small fragments of rock, among which vegetation has a slight foothold. Like the plains, the hills are covered with only a light crop of desert grass, a little sagebrush, cactus, and a few scattered pine trees of stunted growth. The nearest water is Alamo Creek, about 2 miles north of Turquoise Hill, and water for camp use is hauled from Bonanza along this creek. The principal turquoise deposits have been found in the three lower hills, but a little turquoise has been found on the northeast side of the main hill near the bottom. There were rather extensive ancient workings over the best deposits and in some places the greater part of the turquoise had been removed.

The famous mine of the American Turquoise Co., often called the "Tiffany mine" though not owned by Tiffany & Co., is located in the southeast hill. Other claims have been located around this mine, but the quantity of turquoise found has been limited. The old Castilian mine is located on the westernmost hill, and around it numerous claims have been located, accompanied by rather extensive prospecting. The openings on the third hill, lying north of east of this, are small and may be considered a part of those surrounding the Castilian mine. The American Turquoise Co. has six claims including those composing the Tiffany mine and part of the Castilian mine.

Other names have been connected with other claims around Turquoise Hill, but some of these claims are said to have lapsed through want of assessment work. Litigation due to claims dating back to a Spanish land grant of 1728 has tied up the development of many of these turquoise deposits, especially the Tiffany mine. A decision of the court has ruled that some of the deposits lie outside of the Spanish land grant, but there is still some question about others, and development is accordingly being delayed. Active operations have been suspended at the Tiffany mine for several years, but assessment work has been kept up by James P. McNulty, superintendent, for the American Turquoise Co. of New York. The workings consist of numerous pits, open cuts, shafts, tunnels, drifts, and stopes. Some of these openings are ancient, and old stopes have been encountered in the modern tunnels. Two of the larger tunnels, 450 and 225 feet long, respectively, have been driven within the last year or two. They were started about 300 feet east of the company's camp and about 195 feet apart, and were driven in a north of east direction, connecting with shafts and other previous workings. Crosscuts were made from them along promising cross veins. The depth to which the ancient workings had been carried could not be ascertained, but was evidently as much as 100 feet, if not more.

The rock encountered in the workings is probably all monzonite porphyry, which presents different aspects according to the amount of alteration it has undergone. The less altered rock is dark speckled gray and very tough, and that which is more decomposed is light-gray to nearly white, with white spots. The following minerals were observed in a thin section of the less altered rock: Phenocrysts of plagioclase and orthoclase, much clouded with kaolin; abundant epidote; a very little biotite, magnetite, apatite; and abundant patches of calcite. The groundmass was also clouded with kaolin. The epidote is secondary and probably formed from augite. Apatite occurs rather plentifully for that mineral in stout prisms and laths.

The rock has been strongly fractured and jointed and decomposition with kaolinization has been extensive along some of the joint systems. Turquoise has been found in veinlets, seams, and segregations, filling these fissures, joint planes, and fracture zones. The mine workings have followed two sets of veinlets of turquoise striking north of east and west of north with steep dips. Smaller branch veinlets were found to extend from these a few feet into the surrounding rock. The turquoise-bearing streaks of badly decomposed rock are many feet thick in parts of the mine. A few veinlets of quartz and seams of limonite stain are associated with the decomposed rock. The greater part of the turquoise occurs in seams and veinlets but there are some segregations in nodular masses in badly fractured and decomposed rock. There is also a tendency to lens and nodular structure in some of the streaks of turquoise. The turquoise seams range from a small fraction of an inch up, and some an inch thick have been found. The rock in the tunnel and a drift about 40 yards east of the turquoise-bearing zone is stained blue and green with copper minerals.

The best turquoise from the Tiffany mine has a fine dark sky-blue color with an even texture. It is about 6 in the scale of hardness, and has a smooth to conchoidal fracture. Pale-blue and greenish-blue turquoise also occurs. As a rule the best color is found in small seams

and masses, but veinlets of turquoise of good color as much as one-half inch thick have been found. Excellent matrix turquoise has formed where the brown limonite stains have penetrated and filled seams and interspaces in turquoise veinlets and segregations. Such matrix, when cut, would present beautiful contrasts of fine blue and brown with a variety of patterns and markings. Little pure turquoise has been removed since the last regular mining a number of years ago. Some matrix containing bright-blue turquoise in brown iron-stained rock has been encountered in exploration during recent assessment.

Of the many excavations at and around the old Castilian mine, those of the ancients were probably more extensive than the recent ones. The extent and nature of much of the ancient work has been concealed by caving and other agencies of time and by modern work in the same places. Large pitlike depressions and many smaller openings mark some of the ancient work. Numerous prospect pits, trenches, and shafts have been made in recent times. As would be expected little turquoise was left in sight from the last work, and since the deeper workings were not opened little could be learned of the nature of the deposits.

The rock at the Castilian mine is quite similar in appearance to that at the Tiffany mine and may be called monzonite porphyry. Alteration has been extensive and the resemblance of the decomposed rock at each mine is striking. A thin section of the altered rock from one of the shafts at the Castilian mine contained phenocrysts of plagioclase and orthoclase with a groundmass of lath-shaped feldspar crystals with partial trachytoid texture. Other minerals were plentiful, pyrite crystals, magnetite, apatite, and a few shreds of pale brown biotite, much secondary epidote and calcite. Less altered phases of the monzonite porphyry outcropped in places near the mine workings.

From the nature of the work and the type of rock encountered it is probable that the occurrence of turquoise at the Castilian and surrounding claims is similar to that at the Tiffany mine. Several lines of prospects and open cuts have been made in a northeast-southwest direction and other workings also indicate leads of turquoise with a northwest trend. Some good turquoise has been found in the Castilian mine, but a larger proportion is reported to have a greenish-blue shade than at the Tiffany mine.

Other claims have been located east of the Tiffany mine and on the northeast side of the main hill by Mr. McNulty and others. Some of these are reported to carry also copper and gold. A little greenish-blue turquoise has been found in seams and nuggets or nodules in a few of these claims.

CALIFORNIA.

Turquoise has been mined in the northeastern part of San Bernardino County, Cal., by the Toltec Gem Mining Co. and the Himalaya Mining Co., both of New York. These companies have not operated their mines for several years, the Himalaya Mining Co. having closed down in 1903: The Toltec Gem Mining Co. owns three groups of claims known as East Camp, Middle Camp, and West Camp. In a letter from Mr. C. F. Lamont, of New York, treasurer, East Camp is described as 50 miles from Manvel, Middle Camp 5 miles from Ear

Camp, and West Camp 4 miles from Middle Camp and near the mine of the Himalaya Mining Co. The latter mine is about 12 miles N. 60° E. of Silver Lake, a station on the Tonopah & Tidewater Railroad. A visit to the region was made by way of Silver Lake as the nearest railroad point, but a guide familiar with the different localities could not be obtained and only the Himalaya mine was examined. Remains of ancient workings with stone hammers are reported to have been found at all of the turquoise deposits mentioned above. One small crude stone hammer was found near the Himalaya mine at the time of examination.

The Himalaya turquoise mine is on the west side of a group of hills lying northeast of Silver Lake. The hills are rather rough and from them broad débris-filled washes with low ridges slope toward Silver Lake Valley. With the barometer reading 900 feet at Silver Lake the elevation at the turquoise mine was 3,150 feet above sea level. The hills are bare, vegetation consisting chiefly of scattered sagebrush and a few cacti. No water occurs at the surface near the mine but a supply for the camp was obtained from a well. The camp is in a draw about half a mile southeast of the mine. The topographic relief between the gulches and hills around the deposit is from 100 to 500 feet.

The chief workings are in the northwest side of a ridge with rather steep slopes. Other openings have been made to the northwest across a gulch. The workings lie in a north of east and south of west direction and consist of many tunnels, crosscuts, stopes, an open cut, and a shaft. The open cut is nearly 75 feet long and 20 to 40 feet deep and extends from the surface to the tunnel level. A tunnel 75 feet long connects the bottom of the open cut with the surface of the hill and another tunnel enters the open cut from a higher level on the hill side. From the open cut another tunnel has been driven over 100 feet farther south of east. Workings from this tunnel consist of about 100 feet of crosscuts, a large shaped room or downstope 10 feet deep, and a 25-foot shaft in the bottom of the room. Five other irregular benches and tunnels were made in the walls of the open cut, presumably before the latter was carried to its present depth. The dumps of waste rock from the workings cover a large area on the hillside and from them there is a fine view across the desert over Silver Lake Valley to the mountains at the south end of Death Valley.

The turquoise is associated with granite porphyry and this is included in an area of granite. A series of older rocks, probably of pre-Cambrian age, consisting of biotite schist and gneiss, hornblende gneiss, biotite granite gneiss, and pegnatite, outcrops south of the camp. The contact of the granite with this series strikes north of east. Some of the granite contains small hyacinth-colored garnets, and the feldspars are colored a strong pink by inclusions of hematite dust. The granite porphyry in which the turquoise occurs has been decomposed to a spotted buff and gray color. Rough hard ledges of quartz and silicified porphyry outcrop on the hills around the mine. Some of these ledges are heavily stained with limonite and hematite. In hand specimens of the decomposed porphyry, phenocrysts of white decomposed feldspar, glassy quartz, and biotite are recognized in a groundmass. Under the microscope were observed orthoclase

quartz, and partly altered shreddy biotite crystals in a groundmass composed of similar minerals, and grains and veinlets of jarosite or an allied mineral. A somewhat kaolin-like mineral clouds parts of the section. A section of turquoise matrix showed similar minerals with a veinlet of secondary quartz, much sericite, and limonite stains.

Turquoise occurs in seams, veinlets, and a series of nodules and plates in joint planes and fracture zones in the decomposed rock. Also in patches in quartz veins and impregnating decomposed rock. The turquoise seams cut the rock in various directions. From the irregular shape of the workings it was not possible to determine what position the best turquoise leads occupied. It is probable the best gem was found in a rather limited area in a fracture zone somewhat like a chimney deposit. Much quartz with occasional rough crystals is associated with the turquoise. Limonite and a little hematite stain the quartz and turquoise matrix yellowish and brown. The presence of jarosite was recognized after a similar occurrence was determined by Sidney Paige of the United States Geological Survey, in turquoise matrix from the Burro Mountains, N. Mex. The yellow grains and seams were identified by comparison with crystallized jarosite found in a cavity in a quartz veinlet.

As usual with turquoise deposits, a variable grade of turquoise was found. Only fragments and small pieces of veinlets of gem turquoise were left around the mine, but a sufficient variety was seen to form an opinion of the quality of the gem. Considerable low-grade turquoise was seen. The greater part was soft and pale blue, and some might be called semiturquoise. Part was bluish-green and quite hard. The semiturquoise was associated with badly kaolinized soft rock. Some hard pure blue turquoise, that would yield beautiful gems, was observed. This was light baby blue to fairly dark blue. Matrix turquoise, with a variety of markings and colors, occur in the mine and would yield gems showing blue to greenish-blue turquoise, with white, gray, yellow, and brown matrix.

VARISCITE.

There was a large decrease in the production of variscite in 1911 from the two preceding years. This mineral was found at so many localities in the deserts of Nevada and such large quantities were mined that the market was overstocked. The production reported to the Survey was about 540 pounds, as compared with 5,377 pounds in 1910 and 7,135 pounds in 1909. Some of the variscite was reported with the rough gem value and some was given as cut gems. The value of the production in 1911, estimated in part, is placed at $5,750, as compared with $26,125 in 1910. The principal value of the variscite production was from Utah, where the "amatrice" variety is still being mined and cut in some quantity. A production was reported from the Maguire utahlite mine, the first discovered in Utah.

No production of variscite was reported from the Edison & Bird mine north of Lucin, Utah, but a quantity was obtained during assessment work and in opening a newly discovered deposit just southwest of the original four claims. The new deposit is on the Sentinel claim overlapping the southwest corner of the Protection claim, as described in this report for 1910. A specimen from the new claim was sent to the

Survey by Messrs. Edison & Bird. It measured 6 by 4 by 3 inches and was marked similarly to some of the variscite obtained from the Utahlite claim, adjoining the Protection claim on the north. The color of this is a good green, and the markings are such that it would yield beautiful matrix gems. As mentioned in this report for 1910, a granular crystallized variscite occurs at the Edison & Bird mine. A detailed study of the crystallized material was made by W. T. Schaller,[1] of the United States Geological Survey. In the more coarsely crystallized granular variscite some of the crystals are nearly whole, and in the finer-grained material they were only partly developed. Good crystals for measurement occur in small cavities in some of the granular variscite. Mr. Schaller found the crystals to be orthorhombic, with rather simple forms, b(010), m(110), e(012), and in a few crystals a(100). Further investigation of new material, supplied by Messrs. Edison & Bird, has discovered other forms with few, if any, of those enumerated above associated with them, and these crystals will be the subject of further investigation. Three different orientations are given for the crystals, and the relations between these and the similar minerals, scorodite, strengite, and phosphosiderite, are discussed. A chemical analysis was made by Mr. Schaller and the formula deduced from it agrees very well with that usually given for variscite—$Al_2O_3.P_2O_5.4H_2O$. The analysis showed H_2O, 22.68 per cent; P_2O_5, 44.73 per cent; Al_2O_3, 32.40 per cent; with V_2O_3, 0.32 per cent; Cr_2O_3, 0.18 per cent; and Fe_2O_3, 0.06 per cent. No nickel, cobalt, copper, manganese, arsenic, calcium, or magnesium were found.

A further description of Edison & Bird variscite deposits has been given by Leon J. Pepperberg.[2] In this article the location of the deposit is given as sec. 23, T. 8 N., R. 18 W., of the Salt Lake meridian and base line.

MISCELLANEOUS.

BEACH PEBBLES.

CALIFORNIA.

Photographs and descriptions of a choice lot of gems cut from beach pebbles found near Los Angeles were loaned by Dr. Joseph E. Pogue, of the United States National Museum. This information was furnished by Mr. James D. T. Chalmers, of Los Angeles, and is descriptive of a collection of over 500 stones prepared by him. The collection is the result of study and experiment in cutting promising looking pebbles gathered on the beaches during the course of several years. Little attention was paid to mineral varieties, but stones with peculiar textures, odd markings, and pleasing colors were chosen for cutting. The gems include chalcedony, agate, jasper of various colors, and probably several types of rock which have been more or less silicified and altered. Descriptive terms suggested by characteristic features have been used by Mr. Chalmers for some of the stones, such as "enychthyol," "flower stone," "wire agate," "fish egg," and "Japanese stone," but a more comprehensive name for all those not recognized as definite minerals is "beach pebble gems."

[1] Crystallized variscite from Utah: Proc. U. S. Nat. Mus., vol. 41, 1912, pp. 413–430.
[2] Min. and Sci. Press., Aug. 11, 1911, p. 233.

The chalcedony pebbles may be nearly transparent and colorless, translucent gray, pure white, yellowish, reddish, etc. Some of them are mottled with these colors, generally gray and white. The translucent gray varieties are commonly sold as moonstones along the California coast. Jasper in various shades of red, brown, yellow, green, and black, either pure or mottled, forms an important part of other gems. Vari-colored jasper and chalcedony occur together in some gems in odd and pleasing patterns and some chalcedony pebbles have tangled wirelike inclusions. Gems have been cut from vari-colored jasper which exhibit flowerlike patterns.

Beach pebbles which yield very pretty gems are found on the southern end of Santa Catalina Island, Cal., about 1½ miles west of Avalon. The Catalina Novelty Co., of Avalon, has been engaged in cutting these stones for several years, and has applied the name "catalinite" for trade use among tourists. The stone is obtained in all sizes from cobbles over 6 inches thick to small pebbles, but good gem material is not plentiful. They are found over nearly a mile of beach and are probably derived from vein material or deposits from solution in the rock formations now being eroded away along the shores. The composition of these pebbles is variable, so that no definite scientific name can be applied to them. The component minerals are not easily determined, but in some of them there are quartz, calcite, some zeolite-like minerals, hematite dust and particles, limonite stains, and a little pyrite. The hematite dust in quartz forms red jasperlike patches; the quartz and calcite are white and gray; and the zeolite-like minerals are gray and green. Limonite adds yellow and brown stains. The contrasts between the mottled green, gray, white, yellow, brown, and red minerals in polished specimens are very pleasing, and gems for a variety of uses can be cut from "catalinite."

OREGON.

Beach pebbles are collected and cut for the tourist trade along the coast of Oregon as in southern California. The tourists also collect these pebbles to carry off as souvenirs, either polished or in the rough. The curio stores in such coast towns as Newport and Nye Beach and in some inland towns handle many beach pebble gems, and some of them have their own cutting plants. Mr. Sigurd Landstrom, of Lebanon, one of the interior towns, furnished two specimens of beach pebble gems from Oregon for examination. One of these was a cherry-red carnelian and the other a translucent gray agate in which there was a large dark-gray cloudlike inclusion. Both specimens were very pretty. Other types of stones are found and cut, including moss agate, jasper, petrified wood, and rock specimens displaying attractive colors and markings.

FOSSIL CORAL.

Fossil coral is found in several of the Middle Western States, and has been cut for ornamental purposes. During 1911 some of it was cut by the Petosky Steam Agate Works, of Petosky, Mich. Miller Bros., of Iowa City, Iowa, report that in past years they have cut a quantity of fossil coral during the winters for the tourist trade in the summer. Pieces cut into paper weights sell for 50 to 75 cents

apiece. A rough specimen of a variety locally called "fish-egg" coral was kindly sent to the Survey. G. H. Girty, of the Survey, classed this coral as a species of Favosites from the Devonian. It is finely granular crystallized calcite in which the coral structure has been well preserved. A columnar or speckled marking is obtained according to which direction the stone is cut. The color is yellowish-gray, and polishing brings out beautifully the markings due to the texture.

PRODUCTION.

There were many changes in the production of gem minerals reported to the Survey during 1911. The output of some minerals formerly large declined greatly and other minerals formerly of less importance were handled in increased quantities. The production of sapphire in Montana was much greater than during the three preceding years, owing to renewed activity in mining both blue gems in the matrix and varicolored stones from placer deposits. The output of tourmaline and kunzite in southern California, formerly large, nearly ceased. The production of opaque blue-green gems, such as turquoise, variscite, and some copper-ore gems, declined greatly. Increased interest in such gems as agate, moss agate, jasper, and bloodstone resulted in a greater production. The new emerald locality of North Carolina, discovered in 1909, has yielded gems which have been conservatively estimated as worth $10,500 during the last three years.

The total production of gems and precious stones reported to the Survey during 1911 shows an increase over 1910, but is considerably lower than in the years 1907 to 1909. The value of the production in 1911, as reported to the Survey and estimated in part, was $343,692, as compared with $295,797 in 1910. In preparing these statistics it is necessary to estimate values for the output of some minerals, and in doing this the values chosen are an attempt to represent the first sales value of the rough mineral. In some cases the gems are reported to the Survey as cut stones with the proper value for such material, and in other cases it is not evident in what condition of elaboration the stones are reported. The statistics more nearly represent the first values that the rough material brings or might be expected to bring. This same gem material may bring four or five times as much after cutting and placing on the market.

Production of precious stones in the United States in 1908, 1909, 1910, and 1911.

	Value.				Remarks.
	1908	1909	1910	1911	
Agates, chalcedony, etc., moonstones, etc., onyx.	$1,125	$750	$2,268	a $8,128	About 800 pounds, part polished: Arizona, California, Colorado, Missouri, Montana, Utah, and Wyoming.
Amethyst	210	190	.....	725	North Carolina and Colorado.
Benitoite	3,638	500	.....	.....	No production reported.
Beryl, aquamarine, blue, pink, etc.	7,485	1,660	5,545	2,505	About 23 pounds, rough and selected: California, Colorado, Maine, Massachusetts, and North Carolina.
Californite	.....	a 18,000	a 8,000	150	40 pounds; California.
Cathinite	.....	.....	.....	.....	No production reported.

a Estimated or partly so.

Production of precious stones in the United States in 1908, 1909, 1910, and 1911—Con.

	Value.				Remarks.
	1908	1909	1910	1911	
Chiastolite				$25	California.
Chlorastrolite	$25	$2,400	a $2,000	1,992	Rough and cut gems; Michigan.
Chrysocolla	600	300			No production reported.
Chrysoprase	a 48,225	a 84,800	a 9,000	a 13,550	2,035 pounds; California and Arizona.
Cyanite					No production reported.
Diamond	a 2,100	2,033	a 1,400	a 2,750	Arkansas and California.
Diopside	120				No production reported.
Emerald		a 300	a 700	a 9,500	2,510 carats rough; estimated yield of cut gems, 700 carats; North Carolina.
Epidote		15			No production reported.
Feldspar, sunstone, amazon stone, etc.	2,850	a 2,700	2,510	175	145 pounds; California and Colorado.
Garnet, hyacinth, pyrope, almandine, rhodolite.	13,100	1,650	3,100	2,065	Rough and selected; Arizona, California, Colorado, Montana, and New Hampshire.
Gold quartz	1,010		1,000	1,700	California and Colorado.
Jasper, petrified wood, bloodstone, etc.		100	475	2,240	California and Montana.
Malachite, azurite, and azurmalachite.	5,450	2,000	550	800	Arizona, California, and Colorado.
Opal	50	200	270	a 1,875	Nevada, Oregon, and California.
Peridot	1,300	300		360	33 pounds; Arizona.
Phenacite	95	50	50		No production reported.
Prase			100		Do.
Pyrite					Do.
Quartz, rock crystal, smoky quartz, rutilated, etc.	3,595	2,689	1,335	2,140	664 pounds; California, Colorado, Texas, North Carolina, and Maine.
Rose quartz	568	2,970	2,537	1,744	9,920 pounds; South Dakota and California.
Rhodocrosite					No production reported.
Rhodonite	1,250	125	a 6,200	1,300	California.
Ruby				a 210	North Carolina and Indiana.
Rutile		25			No production reported.
Sapphire	a 58,397	a 44,998	52,983	a 215,313	88,477 ounces; Montana, North Carolina, and Indiana.
Smithsonite	a 1,200	300		25	New Mexico.
Spodumene, kunzite, hiddenite.	a 6,000	15,150	33,000	75	California.
Thomsonite	35	100	610	1,500	Michigan.
Topaz	4,435	512	884	2,675	Texas, California, Utah, Colorado, and Arizona.
Tourmaline	a 90,000	a 133,192	a 46,500	16,445	Maine and California.
Turquoise and matrix	a 147,950	a 179,273	a 85,900	a 44,751	4,363 pounds; New Mexico, Arizona, and Nevada.
Variscite, amatrice, utahlite	14,250	35,938	a 26,125	a 5,750	540 pounds; Nevada and Utah.
Miscellaneous gems		1,060	2,755	3,224	Obsidian, datolite, fossil coral, beach pebbles, pink apatite, and ornamental stones with trade names.
Total	415,063	534,380	295,797	343,692	

a Estimated or partly so.

IMPORTS.

The imports of precious stones into the United States in 1911, as reported by the Bureau of Statistics, were large and have been exceeded only by those of 1906. The increase over the imports of 1910 amounted to only $115,949, and over those of 1909 to $502,927. The imports were nearly three times as great as those of the year 1908, during the financial depression following the panic.

inclusive.

Diamonds and other precious stones imported and entered for consumption in the United States, 1906–1911.

Year.	Diamonds.					Diamonds and other stones not set.	Pearls.	Total.
	Glaziers.	Dust or bort.	Rough or uncut.	Set.	Unset.			
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
1908	650,713	180,222	1,636,798	.....	9,270,225	[a] 1,051,747	910,699	13,700,404
1909	758,865	50,265	8,471,192	.....	27,361,799	[a] 3,570,540	24,848	40,237,509
1910	213,701	54,701	9,212,378	.....	25,593,641	4,003,976	1,626,083	40,704,497
1911	199,930	110,434	9,654,219	.....	25,676,302	3,795,175	1,384,376	40,820,436

[a] Including agates. Agates in 1906, $20,130; in 1907, $22,644.