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GEMS AND PRECIOUS STONES.

By Douglas B. Sterrett.

INTRODUCTION.

Features of the precious stones industry during 1909 were the large increase in output of turquoise and turquoise matrix, variscite, tourmaline, and chrysoprase, and the discovery of a new and promising emerald prospect in North Carolina, of new variscite and turquoise deposits in Utah and Nevada, and of a vein of delicately colored rhodonite in California. Blue and green matrix stones increased so greatly in popularity that over 17 tons of rough turquoise and $3\frac{1}{2}$ tons of variscite were mined to supply the demand. Variscite has now nearly gained a permanent place for itself in the popular demand and is to a certain extent displacing the poorer grades of turquoise matrix. A large increase in the output of tourmaline was probably caused in part by the increasing demand for the pink variety by the Chinese merchants in the southern California cities. A new emerald prospect has been discovered in North Carolina near a locality where two emeralds are reported to have been found some years ago. Crystals from the new find have yielded very promising gem material.

Several new trade names have been applied to minerals and rocks recently adopted for use as gems. Among these names are "apricotine" for yellowish-red quartz pebbles, "creoline" for a purplish epidotized trap rock, "verdolite" for a talcose dolomitic breccia rock, "wabanite" for a banded cream and purplish chocolate slate, "carmazul" and "chrysocarmen" for certain copper-ore gems, and "chalchihuitl" for the beautiful calamine obtained from Mexico. Some of these stones are sufficiently beautiful to be used in good grades of jewelry. All of them should fill needs in arts and crafts work. A number of other such minerals and stones have been cut to which no special names have been applied; they are described under the heading "Miscellaneous gems."

AGATE.

ARIZONA.

Specimens of chalcedony or agate and jasper from Mohave County were very kindly furnished by Mr. John F. Gross, of Mineral Park, Ariz. Mr. Gross states that they were found over a stretch of country 2 miles long, about 18 miles southwest of Kingman. These minerals were found on "malpais" mesa land and the hillsides above, The chalcedony occurs in mammillary masses up to an inch in thickness. It ranges in color from translucent gray to reddish and brown. The mammillary lumps are banded, and where some of the layers are stained with iron oxide would make very pretty agates. Some of the rounded surfaces are glassy and resemble hyaline opal. The jasper is similar to that found in many places in the Southwestern States. It ranges in color from reddish-gray to various shades of red, purplish, and black, or Lydian stone. Some of the lighter specimens show a mottling in color. None of the material from this locality has been sold, and no regular work has been done on the deposit.

Specimens of opal and chalcedony were also very kindly sent to the Survey by Mr. Ross H. Blakely, of Kingman, Ariz. These specimens came from the western slope of the Aquarius range of mountains in the southeastern part of Mohave County, about 10 or 12 miles from Owens post office on Big Sandy Creek. Mr. Blakely describes the country as very rough with high ridges and deep canyons. The formations are limestone in porphyry or granite. The opal occurs in many layers, like a bedded formation along a hillside. No gem or precious opal had been found, though only the surface had been prospected. The specimens provided consisted of seams and nodules of opal and chalcedony. The opal varies from translucent white to gray, yellowish, and blue or bluish-green. The chalcedony is gray with some grading into carnelian red and into opaque red jasper. A little moss-agate marking is present in some specimens. It is uncertain whether part of the material should be classed as opal or as chalcedony. It is probable that this deposit will be tested by Mr. Blakely.

COLORADO.

Fancy agates suitable for gem and specimen material have been obtained in some quantity by Mr. J. D. Endicott, of Canon City, Colo., from the Curio Hill locality and the Dinosaur beds near Canon City. These agates cut very prettily and are in some demand. Some of the blue chalcedony from Thirty-one Mile Mountain was also obtained for cutting.

WASHINGTON.

Dr. O. C. Farrington, of The Field Columbian Museum, of Chicago, reports that dealers at the Seattle Exposition sold a considerable number of fossil brachiopod and nautilus shells replaced by white and brown chalcedony. It is said that these fossils were obtained from the San Juan Islands, Washington.

INDIA.

The occurrence of carnelian and agate in India has been described by P. N. Bose.[a] The deposits are in the vicinity of Ratanpur, Damlai, and Dholikuva in the Rajpipla State. The carnelians and agates are found as fairly well rounded pebbles and cobbles, called "akik," in the conglomerates of the upper group of the Tertiary system. These pebbles have evidently been derived from the disintegration of former trap beds in which they formed geodes and veins.

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[a] Rec. Geol. Survey India, vol. 37, pt. 2, 1908, pp. 176–190.

The akik pebbles are generally 2 or 3 inches in greatest length. The gem-bearing beds are worked by pits ranging in depth from 20 to 70 feet with drifts from the bottom. These pits are worked during cold weather only and can not be operated a second season, as the walls cave in badly during wet weather. New pits are sunk each season at a safe distance from the old pits. With better facilities for handling the water encountered in the pits the work could be carried deeper, to the most valuable "akik" beds immediately beneath the conglomerate bed, which would probably be sufficiently firm to form a good roof for the galleries.

The agates fresh from the mines are light colored and generally have a slight milky tinge. The colors are brought out and intensified by baking, by which the maize-colored stones gain a rosy tint, the darker yellow varieties become pinkish purple, the orange-colored stones become red, and the cloudy brown and yellow banded agates become red and white. Pure white agates are rare. The red carnelians range in tint from the faintest flesh color to the deepest blood red. The best stones are those of a deep clear even red color and free from flaws. The agate pebbles are chipped when mined and again after baking to determine their quality and value.

The carnelian deposits of this region have been worked for more than four hundred years. The stones were cut and worked into such ornaments as cups, vases, knife handles, beads, etc., at Limodra, in the earliest times. This industry was transferred to Cambay during the seventeenth century and has continued there until the present time. The carnelians are still baked and sorted at Limodra. The production of carnelian and agate during the five years from 1902 to 1906, as reported to the Geological Survey of India, amounted to 100,000 cubic feet, or 20,000 cubic feet annually. The production recorded during the five years ending in 1878 was valued at £7,000 annually.

AMETHYST.

NEW JERSEY.

According to Mr. Frederick A. Canfield, of Dover, N. J., about a dozen amethyst crystals found at Paterson, N. J., were cut during 1909. These yielded stones ranging in weight from 1 to 3 carats.

MARYLAND.

Prof. A. Bibbins, of the Woman's College, Baltimore, has called attention to the recent discoveries of amethyst crystals at Granite, Baltimore County, Md. Some of the crystals are reported to have yielded very good gems.

APOPHYLLITE.

NEW JERSEY.

Mr. Frederick A. Canfield, of Dover, N. J., reports the collection of about a quarter of a pound of rich brown apophyllite crystals with a fine white chatoyant luster. This apophyllite came from the new Erie Railroad cut through Bergen Hill, N. J. Mr. Canfield believes the specimens would make good cat's-eyes if properly cut.

BENITOITE.

CALIFORNIA.

An excellent description of the new California gem mineral, benitoite, has recently been given by G. D. Louderback, of the University of California.[a] The locality was visited during the summer of 1909 by the present writer, and every facility was given for the examination of the deposit by the Dallas Mining Company through the kindness of Mr. Thomas Hayes, at that time acting superintendent. The following description has been abstracted in part from Doctor Louderback's report and notes supplied from personal observation have been added.

The difficulty mentioned by Doctor Louderback in learning who was the original discoverer of the benitoite property was encountered by the writer. It is evident that J. M. Couch, of Coalinga, grubstaked by R. W. Dallas, was instrumental in finding the deposit. Whether he discovered it while out alone or on a second trip with L. B. Hawkins, of Los Angeles, is a point in dispute. Material taken to Los Angeles by Mr. Hawkins was pronounced volcanic glass and valueless. According to Mr. Couch, specimens given to Harry U. Maxfield, of Fresno, were shown to G. Eacret, of Shreve & Co., San Francisco, and to G. D. Louderback. Specimens cut by Mr. Eacret were thought to be sapphire. Doctor Louderback found the material to be a new mineral and named it benitoite[b] after the county in which it was found.

The benitoite mine is in the southeastern part of San Benito County, near the Fresno County line. The deposit is about 35 miles by road northwest of Coalinga in the Diablo Range, about three-fourths of a mile south of Santa Rita Peak, and on one of the tributaries of San Benito River. The elevation of the mine is about 4,800 feet above sea level; the elevation of Santa Rita Peak is 5,165 feet. The mine is in the end of one of the branching ridges from the south side of Santa Rita Peak. The end of the southward extension of this ridge is a low knob about 160 feet above the creek. This knob is called the apex, and from it a small spur extends to the west down to the creek. The benitoite mine is in the south side of this spur, about 50 feet lower than the apex and 250 feet west of it.

The benitoite deposit occurs in a large area of serpentine which extends many miles northward past the New Idria quicksilver mine and a few miles southward, and forms the summit of an anticlinal ridge pitching down to Coalinga. This serpentine is of the usual type of the Coast Ranges and presents different phases from hard dark-green and greenish-black material to softer lighter-colored rock containing more or less talcose and chloritic minerals. Slickenside seams and lentil-shaped blocks and masses are common through the serpentine, much of which is decomposed near the surface and breaks down to light grayish-green soil which has a greasy feeling when rubbed between the fingers. Inclusions of masses of schists and other rocks of the Franciscan formation occur in the serpentine. These

[a] Louderback, G. D., and Blasdale, W. C., Benitoite, its paragenesis and mode of occurrence: Bull. Dept. Geology Univ. California No. 23, vol. 5, December, 1909, pp. 331-380.
[b] Louderback, G. D., and Blasdale, W. C., Benitoite, a new California gem mineral: Bull. Dept. Geology Univ. California No. 9, vol. 5, July, 1907, pp. 149-153.

schists may be micaceous or more basic, having common hornblende, actinolite, or glaucophane as characteristic minerals.

The benitoite deposit is located in one of these basic inclusions, a portion of which has a somewhat schistose structure, while the rest is nearly massive. These phases were probably originally different adjacent formations that have been metamorphosed. Part of the massive form is a dark-gray to greenish-gray rock that might be called trap. In some specimens the following minerals are determinable under the microscope: Augite, plagioclase crushed and recrystallized and containing clinozoisite prisms, secondary albite, yellow serpentine, and a little titanite and pyrite. The rock is therefore a partly metamorphosed diabase or gabbro. The more schistose phases are grayish-blue to blue and grade into vein material. They are composed of one or more varieties of hornblende, some partially chloritized, with albite, and, near the vein, with natrolite. The hornblende occurs in minute needles, felted masses of needles, blades, and stouter prisms. These have a bluish to yellowish green to nearly colorless pleochroism, and are in part probably actinolite and in part glaucophane or allied hornblende. The natrolite fails and the albite is also less abundant in the hornblende rock at some distance from the vein.

The vein is a highly mineralized shattered zone in the schistose rock. The fractures and joints with the vein filling are about parallel with the schistosity of the rock, which averages nearly east and west in strike with local variations and has a varying dip of 20° to 70° N. A sketch map of a small area on the benitoite mine hill giving the outcrops with their dips and strikes and the formations encountered in the mine workings shows the schist and gabbro inclusion in the serpentine to be quite irregular in shape. The width at the mine between the serpentine walls is about 150 feet and at a distance of 150 feet east of the mine it is only about 90 feet; about 80 feet farther east at the apex it is over 100 feet. This schist inclusion has been described by Ralph Arnold [a] as 150 feet wide at its widest point and at least 1,200 feet long.

The metamorphism of the schist inclusion has been of two kinds—first mashing and sheeting of the original basic rock producing schistosity and opening channels for solutions and then a passage of mineral-bearing solutions recrystallizing and replacing the minerals of the rock with albite. The albite permeated the rock for many feet each side of the fracture zone. The conditions of temperature or pressure of the solutions became changed, so that natrolite was next deposited. The natrolite did not permeate far into the rock, but formed a coating on the walls of the fissures. Neptunite and benitoite were formed with the natrolite at this stage in the fissures and openings but did not penetrate the wall rock. This whole mineralized zone containing many bands and masses of natrolite with gem minerals in the joints, fissures, and open spaces in the brecciated hornblende rock may be called the vein.

The unfilled cavities and seams in the vein zone aided by later fractures and faults has offered an easy passage for more recent decomposing meteoric waters. The latter have leached portions of hornblende schist along and included in the vein, have removed part of the minerals of the vein, and have stained the natrolite on

[a] Science, new ser., vol. 27, 1908, pp. 312-314.

the walls of the cavities and seams with iron and manganese oxides. The rock, leached of albite, has a more or less porous texture and is composed principally of fine fibrous blue hornblende and actinolite.

Development work at the benitoite mine at the time of the writer's visit consisted of a large and a small open cut, a prospect drift or tunnel with a crosscut tunnel, and an incline shaft. The large open cut or "glory hole" was 20 to 45 feet wide, 85 feet long, and from a few feet to 35 feet deep; it had a north of east direction into the hillside. The smaller open cut was to the north side of the entrance of the larger cut and at a lower level, it was about 60 feet long and 10 to 15 feet deep. The prospect tunnel was driven 120 feet in a direction N. 70° E. from the end of the large open cut. The crosscut tunnel was 45 feet long and driven to the north at a right angle from the main tunnel at a distance of 50 feet from the mouth. The incline shaft was sunk 35 feet deep from the north side of the open cut at about the middle.

The prospect tunnel cut through the hornblende schist formation into decomposed serpentine. The contact was evidently a fault line, and near it the serpentine contained much talcose and scaly asbestiform material. The fault was directly across the schistosity with a north-south strike and a dip of 45° W. This prospect tunnel encountered a little natrolite (vein material) in the hornblende schist in its upper west side, 15 feet beyond the crosscut tunnel, which crossed a small streak of vein material containing a little benitoite about 10 feet from the main tunnel. Vein material formed the roof of the prospect tunnel for several feet near its mouth. The "glory hole" was excavated in a very large pocket or bulge in the vein, a portion of which may still be seen along the north wall of the open cut. The incline shaft was apparently sunk in the lower part of this outcrop and did not encounter benitoite. The smaller open cut exposed vein material with benitoite, which was more plentiful near the east end of the cut than at the west end. The vein and the schist in this cut were much blackened and stained with films and seams of manganese dioxide. About 30 feet S. 60° E. of the upper end of the large open cut a ledge of altered blue hornblende schist outcrops prominently. This ledge also carries a streak of natrolite with benitoite. Benitoite has been found in bowlders a few hundred yards west of the mine on the hillside and in the creek. These bowlders have evidently rolled from the outcrop on the hill above and probably from near the mine. Doctor Louderback states that benitoite has been found for a distance of about 230 feet at the surface along the mineral zone and in very small quantity at its extremes. The writer observed benitoite in place through a distance of about 170 feet in an east and west direction.

The strike of the ledge outcropping to the east of the open cut was about N. 60° W., with a high northerly dip. The strike encountered in the tunnel, about 30 feet lower and to the north, was nearly east and west with a dip of about 40° N. In the upper part of the face of the open cut the dip was high, about 65° N., and below the middle of the face it was low, 15° to 25° N. Along the north side of the open cut and in the lower cut the strike was about east and west and the dip was probably rather low, 20° to 30° N. These measurements do not agree closely with those of Doctor Louderback, especially in regard to the dip of the vein. Jointing of the rock and the irregular nature of the vein, however, make accurate measurements difficult. Doctor Louderback places the dip at 65° to 69° N., but the dip measured by the writer is much lower, probably 15° to 30° N. in the lower part of the cut. The evidence for this measurement is found in the position of the vein at the outcrop and in the tunnel, of the layers of blue schist and natrolite in the end of the cut, and of the ledge along the north side of the open cut and in the lower cut. Such a low dip would account for the failure of the incline to cut the mineralized zone. The failure might also be due to the pinching out of the vein a short distance below the large pocket opened in the "glory hole." The impression gained by a study of the deposit and by plotting the location of the vein where encountered in different places was that the deposit consists of an ore shoot pitching to the west and lying in a fracture zone in hornblende schist with an irregular east and west strike and north dip. This shoot had a lenticular cross section with a thickness of more than 25 feet in the thickest part but pinching out on the sides. The upper edge of the shoot has been removed by erosion. A portion of the lower edge was encountered in the tunnel. The eastern extension of such a shoot would have been removed by erosion and the western extension would be underground, to the north of, west of, and below, the open cut.

Doctor Louderback mentions the outcrop of spheroidal gabbro on the southeast of the benitoite deposit on the hillside. The outcrop of rock on the north side of the vein zone, on the summit of the ridge, is of a similar nature and has been mentioned above as diabase or gabbro. The same rock was encountered in the crosscut tunnel 40 feet below the surface and 30 feet north of the main tunnel. Underground this rock occurred in large loose spheroidal bowlders ranging up to several feet in thickness, with large openings between them. This material was difficult to mine and required careful timbering. The open spaces evidently extended to the surface above, as a strong draft of air came through them. The spheroidal shape of the blocks and the open spaces between them were doubtless formed by decomposition and leaching along fracture planes.

The benitoite occurs with neptunite in crusts, seams, and thicker deposits of white natrolite on the walls of geode-like cavities and fissures in the hornblende schist. These deposits occur in both irregularly shaped masses and in seams with more definite directions. They inclose fragments of hornblende schist which has been heavily impregnated with natrolite. In some of the inclusions the gradation from the hornblende rock containing much natrolite to natrolite containing acicular inclusions of hornblende is complete. The benitoite is embedded in or attached to natrolite, being in some places completely, in other places partly, enveloped by it. In the latter places the benitoite projects into the cavities along with the coarse drusy surfaces of the natrolite. Natrolite with or without benitoite and neptunite fills some of the fissures and former cavities completely. The benitoite is always in contact with natrolite and has not been found embedded in the hornblende rock alone. It is in many places attached to hornblende impregnated with natrolite and is partly or completely inclosed in natrolite on the remaining sides. The neptunite is subject to the same relations with the natrolite and is, in places, partly surrounded by benitoite. These facts point to the same period of formation for the three minerals with the power of crystallization arranged in the following order: neptunite, benitoite, and natrolite.

The benitoite is obtained by breaking open masses of vein rock and carefully chiseling or working the crystals out of the inclosing natrolite. Many gems are injured or ruined by this method. The removal of the natrolite by acid has been tried with partial success. Large slabs of rock 2 to 3 or more feet across are obtained coated with natrolite and carrying benitoite and neptunite. The last two minerals are either visible on the drusy surface of the natrolite or are completely covered by natrolite. The position of the benitoite and neptunite is often marked by lumps or a thickening of the natrolite crust. By carefully cutting into these lumps beautiful crystals are sometimes uncovered. Often the inclosing crust or shell of white natrolite can be split from a crystal of neptunite or benitoite in two or three large pieces, so that the covering can readily be replaced over the crystal. Such material makes beautiful specimens. Slabs of bluish hornblende rock with a drusy pure white crust of natrolite containing brilliant reddish-black neptunite and blue benitoite in fine crystals are excellent for the same purpose.

The minerals associated with benitoite are described and analyses are given in the paper of Louderback and Blasdale. Neptunite is titanium silicate containing iron, manganese, potassium, sodium, and magnesium. It occurs in black to reddish-black prismatic crystals of the monoclinic system, the length commonly being several times the thickness. It has a prismatic cleavage and the thin splinters or powder show a deep reddish-brown color. The hardness is between 5 and 6 and the specific gravity 3.18 to 3.19. Neptunite is practically insoluble in hydrochloric acid.

The natrolite, with which the benitoite and neptunite are associated, does not generally occur in distinct crystals of any size. It forms massive granular white aggregates of crystallized material with curved ridge-like or cockscomb-like groups of crystals and drusy botryoidal masses in the cavities. Natrolite is a hydrous silicate of sodium and aluminum crystallizing in the orthorhombic system.

Other minerals occurring in smaller quantity in the cavities are emerald-green copper stain, amphibole needles, albite, aegirine, and psilomelane. The amphiboles are actinolite, a variety intermediate between crossite and crocidolite, and a little glaucophane.

The chemical and physical properties of benitoite and its associated minerals have been described by Louderback and Blasdale,[a] and the following notes are taken from their description. The chemical analyses show it to be an acid barium titano-silicate corresponding to the formula $BaTiSi_3O_9$. Benitoite is insoluble in ordinary acids, but is attacked by hydrofluoric acid and dissolves in fused sodium carbonate. Alone, it fuses quietly to a transparent glass at about 3. The color of benitoite is not affected by heating the stone to redness and allowing to cool. The hardness is greater than orthoclase and less than peridot, or about $6\frac{1}{4}$ to $6\frac{1}{2}$, and the specific gravity is 3.64 to 3.67

Benitoite crystallizes in the trigonal division of the hexagonal system. The common forms observed are the base c(0001), trigonal prisms m($10\bar{1}0$), and n($0\bar{1}10$), and the trigonal pyramids p($10\bar{1}1$) and π($0\bar{1}11$). Other forms are rather rare and of small importance.

[a] Bulls. Dept. Geology Univ. California Nos. 9 and 23, vol. 5.

Of these faces the pyramid π generally has the largest development. This gives the crystal a triangular aspect with the corners truncated by smaller planes. The prism faces are narrow, though generally present. Many of the crystals are naturally etched on one or more sets of faces. Such faces are a little dulled or slightly pitted. Benitoite has an imperfect pyramidal cleavage and a conchoidal fracture.

The mean refractive index of benitoite is greater than that of sapphire, and measures 1.757 to 1.804 (sapphire 1.759 to 1.767). The birefringence is high and the pleochroism very strong. The crystals are generally transparent with a pale to deep-blue and bluish-violet color. Color variations are common in the same crystal, and the change from dark to light blue or colorless may be sharp or gradual. The pleochroism of benitoite is pale to dark-blue or purplish and colorless. The richest colors are seen when the crystals are viewed parallel to the base. The intensity of the blue diminishes as the light ray penetrates the crystal at other angles until perpendicular to the base, when the crystal is colorless. Care is necessary, therefore, in cutting the gem so as to secure the best effects. Pale-colored stones should be cut with the table perpendicular to the base or parallel to the vertical axis of the crystal to secure the full color value. Deeper-colored stones may be cut in the same way or with the table in an intermediate position, if the color is very strong. By cutting intensely colored stones with the table only slightly out of parallel to the base, the color may be reduced to a desirable shade. The dichroscope may be used to determine the position of the vertical axis and accordingly of the base perpendicular to it. When viewed perpendicular to the vertical axis with a dichroscope the twin colors or two rays of light are very intense to pale blue (depending on the depth of color of the crystal) and colorless. When viewed parallel to the vertical axis, or perpendicular to the base, the two rays are colorless and remain so while the dichroscope is rotated. The color of one of the rays becomes stronger as the crystal is rotated from this position. Benitoite crystals exhibiting two shades of color, as dark and light blue or blue and colorless in different parts of the same crystal, may be cut so as to show these variations, or sometimes in such a way that the resulting color is of nearly uniform intensity.

Benitoite has been cut as a brilliant, with the step or trap cut, and "en cabochon." The brilliant cut is especially suitable to show the brilliancy and fire of the gem. The brilliancy is due to the high refractive index and the fire or red flash, often seen in dull or artificial light is, in part at least, caused by the dispersion of the mineral. Of the colors produced by dispersion during the refraction of light in benitoite yellow and green are largely absorbed in the colored gems so that principally red and violet-colored lights are seen. These flashes of colored lights along with the natural fine blue of benitoite render the gem particularly beautiful. The step cut displays the color of benitoite to advantage, with only slight loss of brilliancy. Cabochon-cut gems from crystals with color variations or partially flawed material have some beauty.

The size of the gems cut from benitoite range in weight from a small fraction of a carat to several carats. According to Doctor Louderback the largest perfect stone so far cut weighs over 7 carats and is about three times as heavy as the next largest flawless gem so far obtained. The majority of larger cut stones weigh from $1\frac{1}{2}$ to 2 carats. The principal production is in stones weighing less than $1\frac{1}{2}$ carats.

The use of benitoite in rings or jewelry subjected to hard wear is limited by its comparative softness. The beautiful color, brilliancy, and fire of the gem, however, adapt it to other classes of fine jewelry. Since the supply of benitoite is thought to be limited and a fairly large demand has already arisen for the gem, it is probable the price will be kept high, possibly as high as that of sapphire, its nearest rival in color.

So far benitoite has been found at one place only. J. M. Couch, one of the original discoverers of the benitoite deposit, has located several prospects in formations resembling that at the benitoite mine. In one of these, three-fourths of a mile to the north on the east side of Santa Rita Peak, cavities lined with natrolite crusts and crystals have been found in a bluish hornblende schist rock very similar to that at the original mine. The schist near the vein is composed of bluish hornblende and actinolite needles penetrating granular masses of albite. This rock also incloses crystals of natrolite showing that part of it was formed later than or during the crystallization of the natrolite. In the cavities the natrolite occurs in simple well-developed white columnar crystals up to a centimeter or more in thickness and several times as long. Neither benitoite nor neptunite have been found associated with this natrolite.

BERYL.

MAINE

Dr. O. C. Farrington, of the Field Columbian Museum, of Chicago, reports the purchase of a crystal of golden beryl from Poland, Me., by the museum. The crystal is hexagonal in form and measures $2\frac{1}{2}$ by 1 inch. The purchase price was $60.

Mr. Alfred W. Smith, of the Maine Feldspar Company, Auburn, Me., reports the sale of large beryl crystals and fragments for commercial purposes. This material was not suitable for gems, but was used in the chemical industry. The beryl was obtained during mining for feldspar.

COLORADO.

Mr. J. D. Endicott, of Canon City, Colo., operated the aquamarine deposits on Mount Antero, Colo., during 1909, with some success. Some good gem material and many good specimens were obtained. The deposits have been worked more actively during the open season of 1910 and much fine gem material has been obtained.

CALIFORNIA.

Mr. A. W. Pray, of Escondido, Cal., reports a production of about 20 pounds of white beryl and aquamarine crystals from the Hercules mine, near Ramona. Some of this material is well suited for cabinet specimens, especially that associated with crystallized albite feldspar.

It is reported that the San Diego Company, of San Diego, Cal.,[a] has cut a number of fine beryl crystals. The largest, a pink stone, weighs over 26 carats and is valued at about $400. Other gem

[a] Jewelers' Circ. Weekly, April 6, 1910.

beryls cut were blue, white, and yellow, few green stones having been found on the company's property.

MADAGASCAR.

Morganite, a rose-colored beryl.[a]—In a paper read before the New York Academy of Sciences on December 5, 1910, Dr. George F. Kunz described some new and remarkable gems which had been cut from a rose-colored beryl found in Madagascar. He proposed the name "Morganite" for them in honor of J. Pierpont Morgan, of New York City.

The beryl, together with other gem minerals, is found at Maharita in the valley of the Sahatony, an affluent of the Manandora which passes along the western slope of Mount Bity, Madagascar. The minerals occur in numerous veins of pegmatite which penetrate the alternating layers of limestone mica schist and quartzite. The veins are often nearly 100 feet thick and consist of quartz, amazonite often in fine colors, albite, lithia, tourmaline, lepidolite in deep shades, etc. In these veins magnificent crystals of tourmaline, beryl, and kunzite have been found.

The pink beryl—morganite—has also been found associated with kunzite at Pala, San Diego County, Cal., in large but pale crystals that are sometimes more of a salmon color. At the Madagascar locality, however, it was found in magnificent specimens of gem quality, some of which weighed 98½ carats. Its color is a true rose-pink, a pure, clear color, with less of the magenta tint than is found in even a pale tourmaline and lacking the lilac of the kunzite. It is obtained in larger, finer stones than any other pink gem. When exposed to the Roentgen rays the new beryl assumes a brilliant cerise color under a tube of moderately low vacuum with about 12 or 15 amperes through the tube. When the current is increased the brilliancy of the stones increases accordingly. Under the mercury light it becomes a pale lilac.

This beryl was found by Ford[b] to contain 4.98 per cent of alkalies distributed as follows: Na_2O, 1.60; Li_2O, 1.68; Cs_2O, 1.70. Along with this unusual amount of alkalies goes a slightly higher specific gravity (2.79) and an increase in the mean refreactive index and in the amount of birefringence.

CALIFORNITE (VESUVIANITE).

The massive compact form of vesuvianite, named californite by George F. Kunz[c] has been found at several localities in California. Among these are the Happy Camp region, in Siskiyou County; near the Hawkins schoolhouse and near Selma, in Fresno County; near Lindsay and near Exeter, in Tulare County; and at two points along the Feather River near the Butte-Plumas County line. The Siskiyou and the Fresno County localities have been described or mentioned by Doctor Kunz, and notes on the locality near Exeter were furnished by Frank L. Hess, of the United States Geological Survey, for this report of 1906. The californite deposit in Siskiyou County belongs

[a] Am. Jour. Sci., 4th ser., vol. 31, 1911, p. 81.
[b] Am. Jour. Sci., 4th ser., vol. 30, 1910, p. 128.
[c] Gems, jewelers' materials, and ornamental stones of California: Bull. State Min. Bur. California No. 37, 1905, pp. 93–95.

to D. C. Collier and S. F. Smith, of San Diego. This locality was visited during 1910 and will be described in the report for that year. The mine near Hawkins schoolhouse in Fresno County has been taken up by the Southwest Turquois Company, of Los Angeles. Part of the californite from Fresno County has been cut by the Jupiter Consolidated Jewel Company, of Los Angeles. The prospect near Lindsay, Tulare County, belongs to C. M. White, of Lindsay, and is described below.

The californite from different localities and different specimens from the same deposit differ in color. The better material from the Collier-Smith mine is translucent gray and green, with bright green spots through it, and portions of this californite are nearly bright grass-green. The gem californite from the Southwest turquoise mine has a grass to olive green color; some of it inclines to lemon color and has bright emerald green spots through it. Californite from some of the localities varies from bright green to white and translucent gray or nearly colorless. Specimens in the possession of George C. Mansfield, of Oroville, from the Feather River localities, vary from green to white, and some are nearly colorless and transparent. A cut stone of the transparent material very much resembles moonstone, but there is a possibility that it may be massive white lime garnet, similar to that from the Fresno County californite locality. This material is described by Clarke and Steiger[a] as white and massive, somewhat resembling chalcedony. Specimens of a similar pure white mineral with texture and physical properties like those of californite or jade, have lately been received from Mr. A. Clausen, of Happy Camp, Cal. This mineral was obtained from a bowlder in Indian Creek. It is not possible without a quantitative chemical analysis to state whether it is massive white garnet or vesuvianite.

Californite greatly resembles jade in color, hardness, toughness, texture, and specific gravity, and when first discovered was mistaken for jadeite. It doubtless would be used more largely for this mineral by the Chinese if obtained in larger flawless blocks. A large portion of the californite from some of the deposits is so divided by joints and partings or checked by flaws that it is difficult to obtain specimens that could be used for carving into larger ornaments as bracelets or works of art. The rich color, translucency, and hardness of the mineral, however, render it very attractive for ring or scarf-pin stones, beads for necklaces, etc.

The californite deposit of C. N. White was found in a copper prospect about 6 miles east of Lindsay. Nearly a dozen small openings were made on the south side of the ridge south of Lewis Creek at elevations of 300 feet to 500 feet above the plains to the west. The country rock is serpentine, cut by a dike of hornblende schist. The serpentine is grayish to greenish-black and considerably broken by joints and slickensides. Magnesite seams ranging in thickness from a fraction of an inch to 2 inches cut the serpentine at all angles. White cherty silica or chalcedony seams occur with the magnesite in places. The hornblende schist does not outcrop strongly, though the strike is apparently west of north. It is a fine-grained nearly black schistose rock, composed of green hornblende and plagioclase feldspar. Californite has been found in several of the openings along

[a] Clarke, F. W., and Steiger, George, On "californite:" Bull. U. S. Geol. Survey No. 262, 1905, pp. 72–74.

with small amounts of copper minerals as chalcocite, malachite, and azurite. The green californite grades into pale gray and white material of evidently the same substance, with a pinkish color where bordering on dark greenish serpentine inclusions. Blocks of this material as large as 2 feet across were seen, and slabs with this pleasing combination would yield very handsome ornamental stones for table tops, etc. The best colored californite is nearly grass-green and translucent. Specimens of the lighter-colored and gray varieties have bright emerald-green spots through them. These green patches chipped from the rock were found to contain chromium, which is, therefore, doubtless the pigment giving the green color. Under the microscope in thin section californite is colorless, has a fairly high refractive index, contains only a few minute inclusions of short needles, and varying amounts of specks of a highly birefringent mineral, probably magnesite. Between crossed nicols the birefringence is low, giving a dull greenish-brown color. The mass is composed of numerous close-fitting and interlocking irregularly shaped grains of this peculiar birefringent material. These grains extinguish at all angles as the section is rotated. The exceeding toughness of the californite variety of vesuvianite is doubtless due to this peculiar interlocking granular texture of the mineral. Vesuvianite grains are scattered through serpentine and through magnesite grains and masses, and there seems to be a gradation from masses of one to masses of the other.

CHLORASTROLITE.

Mr. S. W. Barton, of Chicago, Ill., reports a considerable collecting and polishing of chlorastrolites by and for the summer tourists along the shores of Isle Royale, Michigan, but according to Dr. Alfred Lane the quantity found is diminishing and the quality of the chlorastrolite gems is poorer than formerly. Mr. Barton states that he has also found chlorastrolites halfway between the town of Avitonogan and Porcupine Mountain, Michigan, on the beach on the shore of Lake Superior, near the town of Lake Linden in a stream, and in the copper mines at Mandan.

CHRYSOPRASE.

CALIFORNIA.

Chrysoprase has been mined at several places in Tulare County, Cal. The largest operations have been those of the Himalaya Mining Company, of New York. This company has opened mines 8 miles southeast of Porterville, three-fourths of a mile due north of Lindsay, on Venice Hill 8 miles east of Visalia, and at other points. A. A. Prim, of the Franklin Playter Company, of Boston, operated a chrysoprase mine on Venice Hill, adjoining the Himalaya mine. On a small knob one-half mile north of east of Plano a prospect has been opened by A Brooks. This produced mostly chrysopal and common opal. At time of examination all of these mines were idle. The mine of the Himalaya Mining Company near Porterville was only temporarily closed and that of the Franklin Playter Company on Venice Hill had been closed only a few months. The other mines mentioned have not been operated for several years.

The occurrence of chrysoprase at the different mines is very similar. All of the mines are located in hills which are more or less rough and rocky on their upper parts and whose lower slopes pass into the plains or prairie country at their base. These hills rise from 150 to 350 feet above the surrounding country and belong to the first range of foothills of the Sierra Nevada Mountains.

The country rock for the region is serpentine, which is not homogeneous in nature. Different types of basic rocks have apparently been metamorphosed to serpentine, and in some places this metamorphism has not been complete. The serpentine has been more or less weathered so that it is sometimes not readily recognized. Other types of rock occur but are not important near the chrysoprase deposits. Red and brown jasper-like or cherty rock is prominent at each mine and appears to be more or less directly associated with the chrysoprase deposits. This rock forms the rough outcrops so prominent on all the hills containing chrysoprase mines. These jasper or chert masses are irregular in shape and appear to be segregations in the serpentine. They grade into serpentine and in thin section under the microscope are seen to be composed of shattered serpentine more or less replaced by and firmly cemented together with chalcedony, quartz, and opal. The serpentine fragments inclose and are surrounded by particles of iron oxide, chiefly limonite. The serpentine around many of these jasper segregations is more or less decomposed.

The chrysoprase occurs in seams and veinlets in the jasper rock and serpentine. In many places it is associated with chalcedony veinlets and veins. The chalcedony is associated with finely granular crystalline quartz, and these two give place to chrysoprase where the necessary green nickel stains have been absorbed. The chrysoprase consists of chalcedony with a fibrous spherulitic texture grading into fine crystallized quartz with a staining of green nickel salt in the interstices. Some chalcedony can not be distinguished from finely crystallized quartz without the use of a microscope, and as the two are here closely associated the term chalcedony is used to cover both. Common opal in some quantity occurs in the serpentine and jasper formations in veinlets and seams very similar to the seams of chalcedony. Some of it is stained green with nickel and is called chrysopal. Some of the seams and veinlets of chalcedony and opal with their associated chrysoprase and chrysopal occupy regular joints or fissures in the rock and can be traced many yards; others are continuous for a few inches only. The veinlets range in thickness from a fraction of an inch to two or three inches. Larger veins occur but are not often solid chalcedony or chrysoprase. They generally contain more or less chert or jasper filling, with horses or inclusions of wall rock. Magnesite occurs in seams and veinlets in the fresh decomposed serpentine.

The association of the jasper masses with decomposed serpentine at numerous localities indicates a genetic relation between these two. The weathering of serpentine results in free silica, and it is possible that the latter in solution has impregnated portions of the rock along fracture zones and filled joints and seams. Where impregnation has taken place and iron stains were present hard jaspery masses of rock were formed. In the joints the free silica would form chalcedony, quartz, or opal, and if iron oxides were present in quantity, jasper might be produced. Solutions carrying nickel obtained from the serpentine would add the necessary coloring to produce chrysoprase and chrysopal. Since silica is set free during the alteration of the original basic igneous rocks to serpentine, part or all of the silicification of the serpentines into jasper-like masses and the formation of chalcedony and opal veins may have taken place during the original formation of the serpentine. The gradation of chalcedony and chrysoprase veins into silicified serpentine and jasper wall rock indicates that they were formed at essentially the same time.

Mining for chrysoprase in California is generally confined to open work. Where shafts and tunnels have been made they are not deep. The walls of the workings are subject to caving or sliding along slickenside seams sometimes present. Around some of the chrysoprase deposits are shallow pits or depressions and small dumplike mounds which resemble the ancient workings of the Aztecs seen around the turquoise mines of the Southwestern States.

The quality of the chrysoprase ranges from poor to the finest, depending on the purity and texture of the chalcedony and quartz and the depth of the green nickel stains which give the color. The finest gem chrysoprase is highly translucent, with a rich emerald or grass-green color evenly distributed throughout. Such material is often found associated with pale and nearly opaque chrysoprase, grading into translucent gray and white chalcedony and quartz. The nickel-stained opal, chrysopal, sometimes rivals the best chrysoprase in color, but is not so valuable, as it is softer and quite brittle.

The first work on the chrysoprase deposits of Venice Hill is said to have been done by Jerome Prethero and R. V. Methvin, of Visalia, more than fifteen years ago. These men were prospecting for copper, of which the green nickel stains were thought to be an indication. The land was owned by Abe McGinnis as a ranch and was next leased to L. Tannenbaum to be mined for chrysoprase. Later a portion was sold to Tannenbaum and the remainder of the gem-bearing portion to the Franklin Playter Company.

The locality called Venice Hill is composed of a small group of hills rising from 100 feet to over 300 feet above the surrounding plains. This group of hills is more than 2 miles long in a north and south direction and about 1 mile wide. There are two prominent hills about a mile apart, with minor ridges and knobs around them. The chrysoprase mines are on the southeast slopes of the northern hill and about 600 yards apart. The Franklin Playter mine is south of the Himalaya mine and about 100 to 150 feet lower. The country rock on the northern part of Venice Hill is principally serpentine, not homogeneous in composition, with large irregular masses of cherty rock. The serpentine is badly decomposed in places; one portion is still hard and resembles a partly altered trap rock. A large irregular ledge of quartz nearly 100 feet wide outcrops on the western slope of the hill with an east of north trend. The jasper or chert rock masses form hard rugged outcrops on the summits and ridges and in places have veinlets of quartz, chalcedony, or opal associated with them. At one place on the main ridge, west of the workings of the Franklin Playter mine, there was a small hole of unknown depth called "the crater hole" and locally thought to be of volcanic origin. Veinlets of chalcedony and chrysoprase are reported to have been found extending from this hole outward.

This hole may represent a solution channel, but it may equally well be considered the work of ancient miners. Possible evidence of aboriginal mining may be seen in other small depressions and accompanying dumps on Venice Hill.

Franklin Playter mine.—The Franklin Playter chrysoprase mine has been opened by nearly a dozen open cuts with some tunneling and a shaft 30 feet deep. Some of the cuts are merely trenches or crosscuts; others range up to 25 by 50 feet by 20 feet deep. The serpentine country rock gives place here and there to large bodies of red, brown, and yellowish jasper or chertlike rock. This serpentine is not homogeneous in texture or color and in places is badly decomposed and stained with iron oxides. Small seams of magnesite occur in portions of the serpentine as a filling of joints and fissures. Veinlets and seams of chalcedony and opal, with or without nickel stains, cut the rock in various directions. Some of the veinlets prominent in the workings have a northeast trend, though gem material is not confined to them. Chrysoprase and chrysopal veins and seams occur in both the serpentine and the jasper or chert rocks, but they are more plentiful in or near the latter. The jasper and chert masses are very irregular in shape and some of them are not continuous with depth, for the mine workings have been driven under bodies of this rock several feet across.

In one of the principal workings a streak, 2 or 3 feet thick, of scaly talc, with probably some deweylite and soft claylike material was exposed. A large amount of green nickel stain and a vein of common opal, several inches thick, without chrysoprase, was also found in this streak. This common opal varies in color from colorless to white, yellow, greenish, and black, and is of no value. The greater part of the other openings were on hard jasper or serpetine rocks, and some of them encountered both chrysoprase and chrysopal of fine emerald-green color. Gray and white chalcedony and opal veins are plentiful, and some with pale shades of green are not uncommon. The material in the veinlets is said to change abruptly from chalcedony to opal in places, and from the colorless or white varieties to rich green gem material. Indications of this were seen in hand specimens, which show changes both of mineral and of color. The veinlets are quite irregular in size and continuity. Some can be followed for many feet; others pinch out in a few inches. They range from a fraction of an inch to several inches in thickness, though the gem veins are rarely more than an inch thick.

Himalaya Mining Company mines.—The Himalaya chrysoprase mine on Venice Hill was worked by five open cuts ranging from 15 feet wide by 50 feet long and 5 to 20 feet deep to about 100 feet square. The country rock is serpentine, partly decomposed, with local developments of jasper or chert masses. The serpentine is cut at various angles by seams of magnesite, filling joints and cracks. Chrysoprase and chrysopal occur in veinlets and veins along with the associated chalcedony and opal. One prominent vein with an east of north strike and a west dip appears to be traceable through three of the open cuts. This vein is composed of jasper, chalcedony, and opal, with nickel stains producing chrysoprase locally. In places there is no chalcedony, only a jasper streak from a few inches to a foot thick. Other streaks of chalcedony and opal with chrysoprase have been followed in the workings, in places widening out to masses of milk-white opal 3 or more inches across. Veinlets of translucent colorless to pale-green chalcedony are common in the serpentine and chert masses. The change from chalcedony and chrysoprase to opal may occur within a few inches in the same veinlet. The jasper and chert outcrops on the hillside are very rough and irregular. They appear to be segregations in the serpentine, into which they pass by gradation. A microscopic section of the red jasper or chert rock shows it to be composed of numerous grains of a mineral with low birefringence, evidently serpentine, with chalcedony and opal seams and masses filling the interstices. The serpentine grains are both surrounded by veins of limonite and inclose much of it. The chalcedony has a coarse spherulitic texture in places. It acts as a siliceous cement, binding the rock into a hard, cherty mass.

The Himalaya chrysoprase mine near Lindsay is near the top of a rounded hill about 165 feet higher than the surrounding plains. This hill is elongated in a west of north and east of south direction. The mine openings are on the west and southwest side of the summit. The workings consist of two open cuts and a few smaller pits. One of the open cuts is U-shaped in plan and about 60 feet long by 15 feet deep in the deepest part. The hill is composed principally of serpentine, partly decomposed, with rough jasper or chert segregations. Smaller masses of actinolite rock and grano-diorite occur in the hill. The serpentine contains abundant magnesite seams in places. The cherty masses form very rough outcrops. The chrysoprase and the chrysopal occur with chalcedony and opal in seams and veinlets. In the opening some green nickel stains were found in the joints of the serpentine not associated with chrysoprase. Prominent joints or bedding occur in the serpentine parallel with the trend of the hill.

There are a few small pitlike depressions or holes and old dumps in or near the cherty serpentine outcrops on the south side of the hill. These resemble the workings of the Aztecs seen around ancient turquoise mines in the southwest. On the east side of the summit a bare floor of magnesite-seamed serpentine contains numerous rounded holes 6 to 10 inches across and 6 to 8 inches deep. These holes have evidently been made to serve the purpose of mortars for grinding grain either by the Indians or by earlier inhabitants. Several pestles of rounded elongated rocks of hard nature were found near the mortars.

It is reported that the Himalaya Mining Company also operated on a small scale for chrysoprase on a small knob about 1 mile southeast of this mine, or about three-fourths of a mile south of east of Lindsay.

The Himalaya chrysoprase mine, 8 miles southeast of Porterville, has been described in a previous report [a] from notes obtained by Frank L. Hess, of the United States Geological Survey. Additional notes were obtained by the writer during August, 1909, and are here combined with the former description. The mine is in a rough serpentine knob which rises some 350 feet above Deer Creek, half a mile to the north and about 200 feet above the plains on the west. The hill has a north and south elongation with a rough rocky summit. The lower slopes are smooth and pass into the grass-covered plains around the hill. The workings consist of three open cuts with other smaller pits on the southwest slope of the hill and a fourth pit on the

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[a] Mineral Resources of U. S. for 1906, U. S. Geol. Survey, 1907, pp. 1216-1217.

west side. The main working is a slightly sinuous cut 180 feet long in a north and south direction and 5 to 15 feet deep. Two other cuts about 100 feet above this are 30 feet and 20 feet square, respectively, and 10 feet to 15 feet deep.

The country rock is chiefly serpentine, badly altered in places, with segregations of jasper-like or cherty masses. On the west side of the hill where one of the open cuts was made there is an outcrop of dense dark-greenish trap, probably a diabase partly serpentinized. The fresh serpentine is yellow, yellowish green, or green in color, and is compact. The decomposed serpentine is soft and more or less porous and in some places stained with iron and nickel. Both the fresh and the decomposed serpentine are cut at various angles by seams and veins of magnesite ranging in thickness from a fraction of an inch to 2 inches. The jasper-like masses are the usual red or brown hard, silicified serpentine. The whole summit of the hill is covered by hard, ragged outcrops of this rock, which in some places stand 20 feet above the surface of the ground. The rocks are cut by joints and seams of chalcedony, which have a northerly trend and a vertical to west dip. The veinlets of chalcedony range from a fraction of an inch to 6 inches thick and occur in both the chert and the serpentine. Veinlets of common opal and chrysopal are also found in the chert and the serpentine. Chrysoprase occurs, like the chalcedony, in veinlets and seams and may change into chalcedony within the space of a few inches. The best colored chrysoprase is not often found in veins over an inch or two in thickness. In prospect pits along the summit of the hill and on the north end little chrysoprase was found, though a small amount of good chrysopal was obtained.

Brooks chrysopal prospect.—The Brooks chrysopal prospect is on the east side of a small rounded hill half a mile north of east of Plano. A few small pits have been made around rough cherty serpentine outcrops. Common yellowish-green opal was found in considerable quantity in seams and veinlets cutting decomposed and cherty serpentine. Chrysopal of good color is reported to have been found. On the south side of the hill are numerous small pit-like depressions, with the remains of old dumps, which somewhat resemble ancient workings.

ARIZONA.

The blue and bluish-green copper-stained chalcedony from the Globe region, Arizona, described as blue chrysoprase in this report for 1907, is still being cut for gem purposes. This material comes from the Keystone and the Live Oak copper mines, about 6½ miles due west of Globe. The blue chalcedony, or "silicate" as it is locally called, was first taken out and a little was sold by Harvey and Finletter, the original owners of the Keystone mine. The gem material from the Keystone mine is now handled by the company owning the mine through the secretary, H. P. Wightman, of Globe, though some of it is surreptitiously removed from the mines each year by miners and sold to dealers in minerals and gems. The blue chrysoprase is obtained chiefly from the upper levels of the mines along with the other oxidized copper ores.

The Keystone and the Live Oak copper mines are located in a large area of granite with a porphyritic texture in place. In the Keystone mine the ore occurs along a fracture zone, filling seams and joints and replacing portions of the granite. The blue chrysoprase occurs in seams, veinlets, and globular masses, more or less closely associated with chrysocolla.

Much of the mineral is impure or contains numerous inclusions of the chrysocolla or fibrous radial bunches of malachite. The best blue chrysoprase is translucent pure chalcedony with a small amount of blue copper stain. This variety has a distinctive color in daylight and under lamp light possesses a green color very similar to that of regular chrysoprase. The very translucent variety makes a beautiful gem. The most common variety of the blue chrysoprase is cloudy blue and is translucent only on very thin edges. It may grade into the translucent variety or contain inclusions of malachite or chrysocolla. In some specimens this opaque variety is very dull and appears to grade into ordinary chrysocolla. This type of blue chrysoprase does not furnish an especially pretty gem, though a considerable quantity of it is cut. Very pretty cloudlike effects are obtained by cutting the stones with a mammillary or botryoidal structure in which the different layers of chalcedony have received varying amount of coloring matter and are translucent. This is especially noticeable when portions of the chalcedony are nearly clear and colorless. The poorer grade of blue chrysoprase with the associated chrysocolla and malachite would make pretty ornaments if larger pieces were cut and polished.

DIAMOND.

UNITED STATES.

Arkansas.—Conditions in the Arkansas diamond field have been well summed up by John T. Fuller,[a] consulting engineer of the Arkansas Diamond Company. Only slight progress was made in 1909 in developing the mines and prospects because of lack of capital. It is estimated that about 1,000 diamonds, weighing about 500 carats, have been found on the different properties. The outcrop of two peridotite bodies has been definitely determined; other possible occurrences of peridotite are being investigated. There are six properties held by incorporated companies and two by individuals. The Arkansas Diamond Company, the Ozark Diamond Mines Corporation, and M. M. Mauney own the peridotite area first discovered. The American Diamond Mining Company holds all of the second peridotite outcrop so far located. The Grayson McCloud Lumber Company owns a supposed peridotite outcrop at Black Lick. The Kimberlite Diamond Mining and Washing Company and the Ozark Diamond Mines Corporation hold two other supposed peridotite areas.

On the Arkansas Diamond Company property additional prospecting pits were dug to determine more carefully the area of the peridotite outcrop. In August a small diamond washing plant was erected. This consisted of a revolving sizing screen, an 8-foot rotary washing pan, a Hay jig, and a 20-horsepower boiler and engine. The plant was erected to study details for a larger plant with a capacity of 1,000 loads of 16 cubic feet per day of ten hours. At the date of writing (March, 1910), about 800 diamonds have been found according to

[a] Arkansas diamond fields in 1909: Eng. and Min. Jour., April 9, 1910, pp. 767–768.

Mr. Fuller. About 25 of these have been cut and found to be exceptionally fine. The cut diamonds, in an exhibition of some of the diamonds at Little Rock, Ark.,[a] are described as very brilliant, including several very fine blues, some pure whites, and two or three perfect canaries. Among the uncut diamonds is mentioned a pure white flawless half crescent shaped stone for which $125 per carat in the rough is said to have been offered by a New York dealer.

According to Mr. Fuller, prospecting with a core drill was carried on by the Ozark Diamond Mines Corporation on the eastern part of its property. It is believed that a peridotite dike about 100 feet wide with a north and south strike and 20 to 40 feet below the surface has been located. Very little work has been done on the company's property on the main area of peridotite. Nevertheless, about 75 diamonds have been picked up on the 8 acres on this area and the adjoining 2 acres of M. M. Mauney. Mr. Mauney has fenced in his holdings and charges an admission of 50 cents for visitors, who are allowed to search for and keep all diamonds found. The Kimberlite Diamond Mining and Washing Company has prospected its land 3 miles south of east of Murfreesboro by long trenches and shafts 20 to 40 feet deep; a large body of peridotite is claimed to have been located, though no diamonds have been reported.

An accurate description of the first peridotite formation in which diamonds were found, now largely owned by the Arkansas Diamond Company, has been given by George F. Kunz and Henry S. Washington.[b] These descriptions are an enlargement of an earlier description by J. C. Branner and R. N. Brackett,[c] with notes on the discovery of the diamonds. Since these articles were written there has been little new work of consequence and that has been outlined above from Mr. Fuller's article. It is not probable that new discoveries worthy of extended description will be made until the regular development of the mine is started. After the larger washing plant, now under way, has been completed and some thousands of loads of earth have been washed, the diamond content of the peridotite may be determined. Deep mining may bring out new relations between the peridotite and the country rock.

In Branner's report the southwestern one of the three knobs crossing the peridotite area is mapped as peridotite on the summit and part of the way down the west side. Kunz and Washington state that this knob is composed chiefly of Carboniferous sandstone. Along its summit is an outcrop of a hard ledge of bluish-gray rock resembling volcanic tuff, with a north and south strike and a nearly vertical dip. This rock contains angular inclusions of gray and dark-colored rocks, and has biotite scales through it. Chalcedony is present in seams and patches. When examined under the microscope a section showed chlorite, biotite, orthoclase, plagioclase, chalcedony, magnetite, garnet, and inclusions of a brownish isotropic material, probably glass. Such an agglomeration might pass as a volcanic tuff or breccia, but it might also be a contact zone between the peridotite and a graywacke,

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[a] Jewelers' Circ. Weekly, April 6, 1910.
[b] Precious stones: Mineral Resources U. S. for 1906, U. S. Geol. Survey, 1907, pp. 1247-1251; and Trans. Am. Inst. Min. Eng., vol. 39, 1908, pp. 169-176.
[c] Am. Jour. Sci., 3d ser., vol. 38, 1889, pp. 50-59, and Ann. Rept. Geol. Survey Arkansas for 1890 vol. 2, 1891, pp. 377-391.

in which the latter was fractured and partly absorbed by the peridotite. The ridge farther west is composed of more typical quartzite, which forms hard ledge outcrops.

The occurrence of the peridotite at the mine of the American Diamond Mining Company's property, 3 miles south of east of Murfreesboro, was described by A. H. Purdue,[a] and an abstract given in this report for 1908. At the time of examination (July, 1909) the ground on and around the peridotite area at this mine was being stripped of vegetation to aid prospecting and development. Several tunnels, shafts, and pits had been made. In one of the shafts 36 feet deep the very soft decomposed peridotite extended to a depth of 32 feet. The nature of the peridotite at this outcrop is practically identical in appearance with that of the original area. Some of the less decomposed bowlders of weathering found on the outcrop contain a large number of inclusions of black slate and other materials. A thin section under the microscope showed practically the same characters as some of the sections cut from the peridotite on the Arkansas Diamond Company tract, that is, a brownish isotropic matrix with serpentinized olivine grains and small amounts of calcite throughout.

An occurrence of greenish conglomerate rock has led to prospecting for diamonds in Howard County, Ark. The deposit in question is about 4 miles north of Nashville, in sec. 2, T. 9 S., R. 27 W., on Mine Creek. An option on the land has been taken by Messrs. Williams and Cobb through Judge W. C. Rodgers, of Nashville. The conglomerate appears to be a rather recent formation cemented together by lime. It outcrops in the banks and bed of the creek. The rock is rather soft and in places the binding material has been partly leached out, so that it crumbles easily. The whole formation has a green to bluish-green color, and contains pebbles up to 2 or 3 inches in diameter of flint, jasper, chalcedony, quartz, quartzite, rhyolite or dacite porphyry, and more basic rocks somewhat altered. The matrix for the pebbles is a greenish clay containing also sand grains similar to those of the pebbles. With the aid of the microscope the presence of altered brownish chlorite, quartz, orthoclase, iron ores, and a yellowish mineral, probably epidote, were distinguished among the sand grains. The green clayey matrix has a greasy feel like soapstone when crushed, probably due to the presence of chlorite.

Under the supposition that this rock has formed in part from the wash over a peridotite outcrop, it is being tested for diamonds. Only a small amount of the rock had been washed at the time of examination and no diamonds had been found. It would be difficult to prove that this conglomerate does contain the material washed from the surface of decomposing peridotite without a more extended study of the geology of the region. It is probable that the formation is of rather late geological age and may have been laid down in the bottom along Mine Creek only

California.—Two diamonds were found during March, 1910, by a miner named George Stone in the old placer and hydraulic mine at Cherokee Flats, Butte County, Cal. These gems were picked out of a rocker with which Mr. Stone was mining for gold on the land of T. L. Vinton, of Cherokee. A large stone weighing nearly 2 carats

[a] Econ. Geology, vol. 3, 1908, pp. 525–528.

was found first and a smaller stone weighing about half a carat was found about a week later. The nature of these diamonds was not recognized and they were only saved as attractive specimens. The larger stone was sold to T. M. James, of Cherokee, for $10, and the smaller one is reported to have been sold in Oroville. The larger diamond is a brilliant, perfectly clear, flawless stone with a slight tint of yellow. It is a crystal with much rounded and curved faces, either a trisoctohedron or hexoctohedron. The weight is said to be from 1¾ to 2 carats. The crystal is in the possession of Mr. James's mother, through whose kindness the writer was allowed the privilege of examination while at Cherokee.

The work of the United States Diamond Mining Company under the direction of M. J. Cooney has been temporarily suspended. This company owns land 1 mile north of Oroville, on which a deposit of kimberlite is said to occur, and a portion of worked-out gold placers at Cherokee Flats, 8 miles north of Oroville. Many authentic finds of diamonds in the Cherokee Flats placers are on record; there have doubtless been other finds about which little has been heard. Residents of Cherokee state that over 200 diamonds have been found which have generally been picked up by parties interested only in the gold. Some of these diamonds have come from property now owned by the United States Diamond Mining Company. As the early work was for gold alone and as no efforts were made to save diamonds that might occur with it, there may have been gems enough left in the old placers to justify prospecting for them. Some of the rock formation underlying the Cherokee Flats is very similar to that near Oroville, and the United States Diamond Mining Company is preparing to sink a shaft near the old placers.

After visiting the Oroville-Cherokee Flats region (in May, 1910), the writer is ready to hold to the view formerly expressed,[a] that rock formation in the reported diamond pipe near Oroville is practically the same as that in the contiguous country. The portion exposed by the washing off of the overlying placer deposits has been thoroughly decomposed, forming greenish-blue saprolite. In general appearance this saprolite resembles weathered peridotite or kimberlite. Weathering under the porous gravel beds has been extensive, making the complete identification of the rock more difficult. A careful examination of the less altered portions of the "blue" confirms the opinion that it has resulted from the weathering of basic rocks quite similar to those outcropping along Feather River in the vicinity of Oroville. A more complete discussion of these rock formations and their possibilities will be given in this report for 1910.

Indiana.—Occasional finds of diamonds have been made in the region north of Martinsville, in Morgan County, Ind. One of the more recent discoveries was in 1908, of a stone weighing about 1 carat, as reported by R. L. Royse, of Martinsville. Of other diamonds found in this region some are still in the possession of residents of that region. A small diamond weighing about an eighth of a carat, found in the vicinity, is held by the Bradford brothers, of Centerton, 6 miles north of Martinsville. These diamonds are recovered from the pans and sluice boxes of the gold miners, though a careful watch is not kept for them. Bronze-colored sapphire that gives a cat's-eye

[a] Production of precious stones: Mineral Resources U. S. for 1906.

effect when cut cabochon, occasional clear sapphires of variable color, and zircon are also obtained from the placers. A clear colorless zircon from the placers, with a slight reddish stain on its surface, in the possession of the Bradford brothers, weighs 4.62 metric carats in the rough and should cut into a pretty stone.

New York.—The Jewelers' Circular Publishing Company,[a] of New York, has kindly furnished the following information on a reported diamond find in Massena, N. Y. Mrs. L. J. Barbour, now of Farmington, N. H., claims to have in her possession a stone, pronounced by jewelers to be genuine diamond, found in Massena, N. Y., about twenty years ago. It is claimed that her husband found the stone in blasting some rock from the bed of Grass River during low water, on the land of the late Abel Haskell. While the rock was being removed after blasting, Mr. Barbour noticed the crystal on a piece of rock from which he broke it. The stone was used to cut glass, for which it was found quite serviceable. Recently the crystal was examined by two jewelers who reported it to be diamond. One stated it was worth about $500 and the other that three or four good sized stones could be cut from it. This report has not been verified.

SOUTH AFRICA.

Cape Colony.—The twenty-first annual report of the De Beers Consolidated Mines [b] shows that the operations of the company were carried on in a limited way during the greater part of the year. The Kimberley, Wesselton, and Bultfontein mines were operated through the year; the De Beers mine was worked only during the month of July, 1908; and the Dutoitspan mine was closed the whole year. The total production of blue ground at all the mines was 3,557,975 loads of 16 cubic feet, as against 5,497,782 loads in 1908, and the total quantity washed was 4,774,172 loads in 1909, as against 4,965,323 loads in 1908. The stock of "blue" on the floors, not including the hard cylinder lumps, was decreased from 9,955,123 loads in 1908 to 8,738,926 loads in 1909. Though no statement is made of the number of carats of diamonds obtained in 1909, estimates made from the figures given show the output to be very close to that of 1908, which was 1,859,131 carats. The value of the diamonds sold and of stocks on hand at cost of production was £3,074,912, as compared with £3,354,524 in 1908 and with £6,452,597 in 1907. The average cost of mining and washing the diamonds was materially reduced in all the mines but the Bultfontein. The number of carats of diamonds obtained per 100 loads of "blue" washed was increased from 37 to 42.1 in the De Beers and Kimberley mines, from 27 to 34 in the Wesselton, and from 32 to 38 in the Bultfontein. That the prospects of the company are brighter is shown by the fact that the sale of diamonds during the first six months of 1909 amounted to over half of the total sales during the two preceding years.

Transvaal.—The production of diamonds in Transvaal [c] during the fiscal year amounted to 1,929,492 carats, valued at £1,295,296, a decrease of 254,998 carats in quantity and of £584,255 in value

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[a] Personal correspondence dated November 11, 17, and 21, 1910.
[b] Twenty-first Ann. Rept. De Beers Consolidated Mines for year ending June 30, 1909.
[c] Ann. Rept. Gov't Min. Eng., Transvaal, 1909.

in 1909, as compared with 1908. The production came from seven mines, sundry prospects, and the alluvial diggings at Christiana. The last contributed 1,372 carats of diamonds, valued at £4,560. The production of the Premier mine [a] during the years ending October 31, 1908 and 1909, are here given. In 1909 7,517,793 loads of earth were washed, yielding 1,872,137 carats of diamonds, valued at £1,172,378, as compared with 8,058,844 loads washed, yielding 2,078,825 carats, valued at £1,536,720, in 1908. It is reported [b] that another large diamond weighing over 191 carats has been found in the Premier mine. This diamond is described as a pure white stone, absolutely flawless, measuring about three-fourths of an inch thick, and tapering from 1¼ inches to three-fourths of an inch in breadth.

Orange River Colony.[c]—The production of diamonds in the Orange River Colony during the fiscal year ending June 30, 1909, is given by Burnett Adams as 654,319 carats, valued at £1,048,607, as compared with 505,452 carats, valued at £1,069,942, in 1908. The yield in carats per 100 loads washed was 11.33, as compared with 10.38 carats in 1908. The average price per carat fell from 42s. 1d. in 1908 to 31s. 11d. in 1909. The average price per carat for the first part of the year was only 24s. 9d., but it rose to 36s. 3d. as the market became stronger. The production came principally from the Jagersfontein, Koffyfontein, Roberts Victor, New Driekopjes, Voorspoed, and Lace mines. The output from the alluvial diggings along Vaal River was 3,017 carats, valued at £11,496, as compared with 5,447 carats, valued at £18,217, in 1908. The three largest diamonds found weighed 30¾, 30⅜, and 26¼ carats, and were valued at from £200 to £170 each.

German Southwest Africa.—The discovery of diamonds [d] in German Southwest Africa was first announced on June 23, 1908, by a telegram from the governor of the Province. A little later the diamond fields were taken over by the Government. On January 6, 1909, the trade in diamonds from this colony was regulated by the establishment of the régie or monopoly. From the time this syndicate took charge of the output to October, 273,701 carats of diamonds, valued at $1,900,300 were delivered, and the production now amounts to about 45,000 carats per month.[e] These diamonds are not large, though some weighing 17½, 10¾, 8, and 4½ carats are reported to have been found. The average weight of the diamonds is about one-third of a carat, though stones weighing 1 carat are not rare. The stones are of fine luster and transparency, and occasionally yellow, red, green, and blue diamonds are found. It is the aim of the German Government to have the stones from the Southwest Africa Colony cut by home lapidaries. At present there are sufficient diamond cutters in Germany to handle only a small part of the output, and some stones are being cut in other countries.

Three theories have been advanced [f] to explain the origin of the diamonds of German Southwest Africa, namely, that the diamonds may be of local origin; that they may have come from former land

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[a] South African Min. Jour., March 12, 1910.
[b] Jewelers' Circ. Weekly, July 20, 1910.
[c] Mines Dept. Orange River Colony, Sixth Ann. Rept., 1909.
[d] Min. Jour., London, March 3, 1910.
[e] Diedrich, Henry W., consul-general: Weekly Cons. Repts., May 28, 1910, p. 578.
[f] Marlott, R., Min. Jour., London, November 27, 1909.

now under the sea; and that they may have come from the Vaal River country.

The rocks of the diamond region are principally gneisses and granites. The diamonds may possibly be derived from such formations, but it is probable that they have come from pipes of volcanic kimberlite. So far no such rocks have been found in the diamond region.

The existence of land in Cretaceous times to the west of the present coast when the latter was submerged, has been argued as a possible source. The diamonds may have come from diamontiferous formations in this land and been washed down with the sediments forming the Cretaceous sandstones and deposited with them. By a later elevation of these sediments and by weathering processes the diamonds were liberated and accumulated during the removal of lighter and less resistant material by erosion.

The possibility of the diamonds coming from the Vaal River region from which they have been washed by Orange River is also argued. The distribution of the diamonds along the seacoast would be affected by ocean currents. Although the Vaal River diamond deposits are some 500 miles away, there are numerous waterworn pebbles of agate, etc., found with the diamonds of German Southwest Africa that resemble those found in the Vaal River region.

SOUTH AMERICA.

British Guiana.—The exports of diamonds from British Guiana[a] during the calendar year 1909 amounted to 5,646 carats, valued at $39,060, as compared with 4,968 carats, valued at $40,872, in 1908. The number of diamonds declared to the Government during the fiscal year 1909 is given by Consul Arthur J. Claire, of Georgetown,[b] as 56,982 stones, weighing 5,189 carats. The same authority quoting further from a report by the commissioner of lands and mines says that in the early days of the gold-mining industry of British Guiana diamonds were often found in the daily clean-ups. Later, in 1890, an expedition to the upper Mazaruni in search of gold found diamonds in considerable numbers though of small size. The first regular mining was done in 1900 by the British Guiana Diamond Syndicate working on a concession of 2,000 acres on Putareng Creek, a tributary of Mazaruni River. The syndicate has since gone out of existence. Still later another company, the Mazaruni Company, took up and still works a concession of 5,858 acres in the same district. Diamonds have been found on the left bank of Curibrong River, near its confluence with Potaro River. Work in this locality was abandoned, as the stones were not plentiful and were small in size, averaging about 10 or 15 to the carat.

AUSTRALIA.

New South Wales.—The production of diamonds in New South Wales[c] during 1908 amounted to 2,205 carats, valued at £1,358, a decrease of 334 carats in quantity and of £698 in value from the output of 1907. The total production since 1867 is estimated at 161,880 carats, valued at £107,503.

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[a] Min. Jour., London, January 29, 1910.
[b] U. S. Daily Cons. Repts., No. 3636, November 15, 1909.
[c] Ann. Rept. Dept. Mines, New South Wales, 1908, pp. 53-54.

DIAMOND INDUSTRY.

Increased value of the diamond.—With the revival of the trade in diamonds during 1909 an advance of 12½ per cent [a] in the wages of the members of the Diamond Cutters' Protective Union was granted by the Diamond Cutters' Association in New York. This advance places the scale of wages a little higher than they were before the panic of 1907. It is estimated that the increase would mean an advance in the cost of manufacture of about $1.50 a carat on the larger sizes and of $2 a carat on the smaller stones. A previous advance of 12½ per cent in wages was made on August 1, 1909. There are about 350 diamond workers in New York who receive wages of $35 to $75 a week. The Diamond Cutters' Protective Union is very strict about increasing the number of its members, admitting only so many as are needed to meet the requirements of the employers. From three to five years are required for a man to become a skilled diamond cutter, and with the strict requirements of the union there are not many that qualify.

An increase in the wages of the diamond cutters combined with an increase in the value of the rough diamonds sold by the London syndicate [b] will doubtless be reflected in the price of diamonds to the buyer. An increase of 3 to 4 per cent on all rough diamonds controlled by the London syndicate was made in August, 1909. Consul Henry H. Morgan, of Amsterdam,[c] reports continued increases in the price of diamonds from the De Beers mines. Increased values are due to the failure of the mines to meet the demand. During the times of depression when the output of the mines was limited the idle laborers from the diamond mines found employment in the gold mines and elsewhere. With a renewed demand for diamonds the De Beers company has not been able to secure the labor necessary to run the mines on a sufficiently large scale. The largest increase in price of diamonds has been placed on stones above three-eighths of a carat. With the smaller stones the price could not be raised so much on account of competition with the diamonds from the Premier mine and from German Southwest Africa.

Along with the announcement of the renewal for five years of the agreement[d] between the De Beers Consolidated Mines (Limited) and the diamond syndicate of London comes a report of a working agreement with the Premier mine. Reports of an agreement between the London syndicate and the German régie have appeared and been denied. It is not likely that any agreement has been reached but, the German régie will find it advantageous not to turn out too large a production of small diamonds. It is probable that a considerable number of the German Southwest Africa diamonds are turned indirectly into the hands of the London syndicate.

Sale of the Hope and other large diamonds.—During a sale at auction in Paris of a number of large diamonds, among which was the Hope blue diamond, surprisingly small sums are reported by the Manufacturing Jeweler to have been paid for the finest stones.[e]

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[a] Jewelers' Circ. Weekly, February 9, 1910.
[b] Jewelers' Circ. Weekly, September 1, 1909.
[c] Jewelers' Circ. Weekly, April 6, 1910.
[d] Jewelers' Circ. Weekly, July 20, 1910.
[e] Manufacturing Jeweler, July 8, 1909.

Metric carat.—In connection with the Cullinan diamond, attention has been called by L. J. Spencer[a] to the uncertainty that may arise through the use of the term carat to express the weight of precious stones when that weight varies in different countries. In descriptions of the Cullinan diamond no less than eight different weights, varying from 3,024 carats to 3,253¾ carats, have been used by different writers. After considering the care used in determining the weight of the diamond in the different weighings and making a study of the weights and balances used, Mr. Spencer places the weight of the Cullinan diamond at 3,025¾ English carats of 205.304 milligrams. This weight expressed in the metric system is 621.2 grams. If the metric carat of 200 milligrams becomes standard the weight of the Cullinan diamond would be 3,106.0 metric carats. The metric carat weight has been proposed by the International Committee of Weights and Measures. In France its use is compulsory by law. According to the Berlin Tageblatt,[b] the Belgian Government has also defined the carat weight to be 200 milligrams. The metric carat was adopted by Spain[c] on March 11, 1908, as the official carat.

New form of diamond cutting.—J. L. Gonard, of Brooklyn, N. Y., is reported[d] to have made an improvement in the form of diamond cutting. The table of the stone is given a concave surface, which may be obtained and apolish be imparted by a machine of simple construction. It is claimed that a much greater brilliancy is obtained in this form of cut.

EMERALD.

NORTH CAROLINA.

A new emerald locality was brought to light in North Carolina during 1909. It 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. It is reported two emeralds were found some fifteen years ago about a mile southeast of Mr. Turner's. Little interest was shown in these emeralds locally, and no further prospecting was carried on for them. Mr. George L. English, then of New York, endeavored to find the locality from which these crystals came, but without success. Through the kindness of Mr. English, now of Shelby, N. C., the writer was informed of the recent discovery of promising crystals of emeralds on the Turner place and a trip to the locality was made in December, 1909. Up to that time some ten or a dozen crystals had been found loose on the surface of the ground. These crystals have a fine dark grass-green color. They are more or less checked, and some contain silky internal markings. The largest emerald found measures about 1 by ¾ by ½ inch. It is about half of a crystal split parallel with the length. The other stones range in size down to about a carat in weight in the rough. Some are nearly whole crystals and others are fragments of crystals. All of them are rather strongly etched and striated. One of the crystals was cut into a faceted stone of less than

[a] Spencer, L. J., Notes on the weight of the "Cullinan" diamond and on the value of the carat-weight; Mineralog. Mag., vol. 15, No. 71, March, 1910, pp. 318–326.
[b] Manufacturing Jeweler, Oct. 21, 1909.
[c] Kunz, G. F., and Stevenson, C. H., The Book of the Pearl, p. 327, Century Co., 1908.
[d] Manufacturing Jeweler, May 12, 1910.

2 carats weight and reported to have been valued by the lapidary at $20. This stone is not one of the best of those found and is rather badly flawed. The majority of the emerald crystals are checked and flawed, but there are portions in some of the crystals that would yield small clear gems of fine color. Minerals associated with the emerald crystals in the soil are colorless and smoky quartz crystals and black tourmaline.

The emeralds found loose in the soil came 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 at about the same distance on the north. The field in which they were found has been cultivated and the emeralds were exposed by plowing and washing by rains. Crystals of quartz and black tourmaline are found at other points on the surface near the emerald prospect. At a point about 150 yards due northeast these crystals occur rather plentifully. Between these points thin seams or shells of chalcedony were found loose in the soil. At the time of visit no development work had been done, and, as the rock outcrops are few and badly weathered, the geology was not well worked out. 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 the 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 rocks of this portion of the Piedmont Plateau are principally gneisses and schists, of great age, intruded by masses of granite and diorite. In the vicinity of the emerald prospect the types of rock are varied. There are mica, cyanite, garnet, and hornblende gneisses and schists cut by granite or quartz monzonite, gabbro, diorite, and pegmatite. The trend of the rock formations is to the northeast and and east of north near the prospect, and west of north a mile farther in that direction. The dip is generally to the southeast.

Hornblendic rocks are prominent in the gneisses and schists on each side of the emerald deposit for a distance of a mile or more. These hornblende rocks are in part, at least, metamorphosed phases of the gabbro masses occurring in the region. The gabbro outcrops form large rounded spheroidal bowlders of weathering where the rock has not broken down to soil. The granite forms a few ledges of grayish semidecomposed rock in rather light sandy soil. The gabbro and hornblendic rocks form dark reddish-brown clay soils. The emerald prospect is in a small area of basic rock with granite or monzonite outcrops on either side. Specimens gathered from the surface of the ground consist of gabbro, hornblendite or amphibolite after pyroxenite, chloritized amphibolite, and pegmatite. About 20 yards west of the emerald prospect is an outcrop of biotite granite or quartz monzonite. The width of the gabbro belt is over 100 yards, and the rock on the east side is granite or quartz monzonite.

The gabbro outcrops in a few large nigger-head bowlders with a grayish-black color and medium grain. Under the microscope the constituent minerals are found to be red-brown hornblende, colorless augite, olivine, bytownite feldspar, biotite, and pyrrhotite. The olivine grains have around them reaction or alteration rims, probably composed of actinolite. The biotite has a strong yellow to reddish-brown pleochroism. The amphibolite was found only in small blocks on the surface and has a greenish-yellow or brown color. The constituent minerals are chiefly pale-brown hornblende, with small amounts of augite and iron ores. The hornblende appears to be formed from pyroxene. The chloritized amphibolite has a greenish color and grades into chlorite schist or "soapstone." It is composed of chlorite, green hornblende, actinolite, biotite, iron ores, and small amounts of plagioclase feldspar. The quartz monzonite rock on the west of the prospect is a speckled gray rock of medium grain, composed of quartz, feldspar, and mica, and the field name would be biotite granite. The microscope shows the component minerals to be quartz, andesine feldspar, biotite, muscovite, and a little zircon. The rock should therefore be classed as quartz monzonite.

The gradations from very basic rocks to more acid types in a small area suggest either a basic segregation in the original igneous magma or an inclusion of a basic rock mass in a more acid or granite magma, with an absorption by the latter of part of the former. Results of the latter process are in evidence at numerous localities in the Piedmont Plateau, and the formations of the emerald locality seem to adapt themselves well to this theory. An original mass of gabbro, probably with more basic phases as pyroxenite, was inclosed in a large intrusion of granite magma. The gabbro was broken and blocks of it were floated off and partly or completely absorbed by the granite magma. The latter became more basic near the gabbro mass and graded into it. Thus rocks ranging from ordinary granite to monzonite, diorite, and gabbro would be formed around the original gabbro. This series may be seen more plainly at other places in the neighborhood. Through the fractures and fissures pegmatitic magmas or solutions passed from the cooling granite into the adjacent rocks, forming pegmatite dikes and veins such as that in which the emeralds have been found.

In April, 1910, and more recently some prospecting was done at the emerald locality. Mr. English has kindly furnished notes on the results of this work for the following description and loaned a representative collection of wall rock, vein matter, and emeralds for examination. Developments consist of a pit 6 feet deep, a trench 14 feet long started in the hillside to drain the pit, and another trench 25 feet long at a distance of 15 feet northwest of the pit. A pegmatite vein or lens was found, which has a thickness of 30 inches at the surface on the east side of the pit and 18 inches on the west side. In the bottom of the pit the vein has a thickness of about 18 inches on each side. The 25-foot trench was cut to a depth of 3 feet and did not encounter any pegmatite. The vein strikes about N. 70° W. with a dip of 75° N.

The pegmatite 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 texture of the pegmatite varies from medium-grained to fairly coarse, with nearly pure feldspar and quartz masses 18 inches through. The crystallization is not especially good, though some fairly well developed crystals are found in small rude miarolitic cavities. Crystals found in the cavities are colorless and smoky quartz, albite feldspar, with sometimes black tourmaline and green 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. The emerald crystals found in the vein are smaller than most of those found on the surface and have a much paler color. A considerable number of these beryl crystals were found, ranging from pale emerald green to a fairly dark green. Mr. English washed three washtubfuls of partly decomposed vein material and obtained 34 small crystals and fragments of emerald. There were no emeralds visible in this material before washing. 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 cleveландite 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 colored. One crystal of quartz examined is penetrated by numerous fine light-colored needles, probably 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. In some cases 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. A pretty specimen of emerald in the matrix found in the vein consists of light emerald-green beryl crystal 17 millimeters long and 3 millimeters in diameter embedded in quartz and albite. The emerald is partly embedded in each mineral. The quartz has a light smoky color and is roughly crystallized. The albite also shows rude crystallization and, along with the quartz, is slightly stained with iron. The emerald is transparent, though somewhat checked by flaws. Some of the faces of the prism zone are much striated.

Among the specimens loaned by Mr. English were 16 cut gems. One of these was a faceted table cut stone of 77 milligrams or 0.385 metric carat weight and might be worth from $5 to $10. The stone had a flaw in the middle and was light emerald green. The rest of the stones were cut cabochon and drop shape and were nearly all dark colored, some of a fine emerald green. All contained checks and flaws or silky striations. The dark-colored stones of this grade might be valued at from $20 to $25 per carat. Three drop-shaped emeralds weighed 326, 267, and 251 milligrams, or 1.63, 1.33, and 1.26 metric carats, respectively. These three stones were sufficiently well matched to be used as pendants in a necklace and, though more or less flawed, had a good color. They should be worth at least $25 a carat. Other gems cut cabochon were of better quality, though slightly paler in color than the three drop-shaped stones. Several of the emeralds cut cabochon exhibit a fairly good cat's-eye effect along the silky internal striations, very similar to the effect and due to the same cause of the tourmaline cat's-eyes from southern California. The crystal from which the faceted gem was cut was obtained from the pegmatite vein. The other stones with deeper color were cut chiefly from crystals found on or near the surface.

As the prospect pit has been made on the hillside below the point at which some of the emeralds were found and has yielded only gems with a paler color than those found on the surface, it is possible that there is another vein.

Mr. Thomas English, of Sprucepine, N. C., reports the discovery of a new emerald prospect near the Emerald Matrix mine, on Crabtree Mountain, 4 miles southwest of Sprucepine, in Mitchell County. The new prospect is about a quarter of a mile north of the old mine and considerably lower down on the side of Crabtree Mountain. Only a few blasts had been put in, and several specimens had been obtained. These crystals are said to have a little paler color than those of the old mine. Some of the emeralds are of pencil thickness, though most of them are somewhat checked. The best emerald matrix material is said to be the dark-colored quartz wrapped in scaly biotite.

FELDSPAR GEMS, AMAZON STONE.

COLORADO.

Some good amazon stone was mined by J. D. Endicott, of Canon City, Colo., at his claim 4 miles north of Florissant. Part of the product was cut and part was disposed of in the rough. The better grades of amazon gems from this locality are very good.

GARNET.

ARIZONA.

The geographical location of the "Arizona ruby" or garnet field, described in this report for 1908, has been obtained a little more accurately by the work of H. E. Gregory in the search for water for the Navajo Indians. The locality is not on the northwest side of Gypsum Valley, in Utah, but in Arizona on the southeast of Gypsum Valley, about 4 miles south of the locality given by the writer in this report for 1908. When the locality was visited it was without the aid of a detailed map and with an Indian guide who could not speak English. The lack of water and supplies and the limited time for so long a trip made it difficult to secure the proper data of location.

IDAHO.

Garnets suitable for cutting into small gems are occasionally picked out of the gold placers in various parts of Boise County, Idaho. In the Deadwood Gulch placers dark-red garnets as large as pecan nuts have been found. Some of these are sufficiently clear and light-colored for cutting into faceted gems, while others are so dark as to be suitable for carbuncle cuts only. Specimens examined were partly water-worn fragments of crystals with a few of the crystal faces still present. Miners report these garnets to be rather plentiful.

CALIFORNIA.

Fine specimens of hyacinth-colored garnets are reported from the Hercules mine, near Ramona, by Mr. A. W. Pray. The best specimens consist of the garnet associated with albite feldspar. About 50 pounds of this material was mined.

PENNSYLVANIA.

Specimens of rough garnet in mica schist and gems reported to have been cut from them were kindly loaned by Mr. Frank C. Reighter, of Chicago. Mr. Reighter obtained these from a locality in eastern Pennsylvania. Some of the cut gems have the fine violet red color of almandine.

IOLITE, CORDIERITE.

CONNECTICUT.

Prof. S. Ward Loper, of Wesleyan University, reports the collection of 75 good specimens of iolite or cordierite at Guilford, Conn. Some of this material has crystal forms. The collection has been placed in the museum of Wesleyan University.

JADE.

BURMA.

The exports of jade (jadeite) from Burma through Rangoon in 1908 amounted to 3,211 hundredweight,[a] valued at £73,400, as compared with 2,636 hundredweight, valued at £49,643, in 1907.

NATROLITE.

NEW JERSEY.

Mr. Frederick A. Canfield, of Dover, N. J., reports the finding of about 30 pounds of large crystals of light-brown natrolite at Paterson, N. J. Some of these crystals were to be cut for gem purposes.

CALIFORNIA.

The occurrence of natrolite with benitoite in California has been described under benitoite. None of the California natrolite has been used for gem purposes, though the pure white masses of globular and mammillary natrolite with drusy surfaces associated with benitoite and neptunite make splendid cabinet specimens.

OBSIDIAN.

OREGON.

Specimens of leek-green obsidian, exhibited at the Seattle Exposition, are mentioned by Dr. O. C. Farrington, as possible gem stones. The material is clear, though rather badly fractured, and would yield small gems only. It is reported to have come from Mount Hood.

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[a] Rec. Geol. Survey India, vol. 38, pt. 1, 1909.

OPAL.

NEVADA.

Prof. J. C. Merriam, of Berkeley, Cal., has kindly furnished further information on the occurrence of the opal in Humboldt County, Nev., mentioned in this report for 1908. According to Professor Merriam, the opal occurs in the Virgin Valley formation, as described by him.[a] This formation is of Tertiary age and in places carries good opals in veins or cracks in fossil-bearing beds.

Specimens of opal from this region, furnished by Mr. H. E. Rinehart, of Denio, Oreg., exhibit a splendid fire and display of color, though none of large size was seen. Some of the specimens are opalized wood, in which nearly all of the woody texture has been lost. Such specimens as were seen are petrifactions of small limbs of trees and consist of opal of fine quality.

Mr. R. C. Hills, of Denver, Colo., refers an opal deposit tested by himself in the Virgin Valley region to the John Day Miocene formation. At this deposit tusks and teeth of a mastodon were found during the digging for opals. Considerable opalized wood and some white opal occur in the vicinity, but little good gem material is found. Black and green gem opals were found in a space about 2 rods square. The gem material was rather badly checked and flawed, and few fine gems were found. Probably not over $200 worth were taken out during 1909.

AUSTRALIA.

New South Wales.—The value of precious opal produced in New South Wales [b] in 1908 amounted to £41,800, as compared with £79,000 in 1907. The White Cliffs division of the opal region furnished £31,800 and the remainder came from the Walgett division. The latter production consisted chiefly of high-grade dark opal, known as "black opal" in the trade. The large decrease in the value of the production of opal is not so much due to the falling off of the quantity or quality of the gem produced as to a decline in the market price, especially in the United States, where the gem has hitherto found its readiest sale.

During 1909 opal mining was carried on actively in the White Cliffs and the Lightning Ridge or Walgett regions. Much fine gem material is reported [c] to have been found, for some of which £5 to £10 per ounce was paid, and £30 per ounce for other parcels.

Queensland.—The production of opal in Queensland [d] in 1908 was estimated at £2,500, as compared with £3,000 in 1907. The production was obtained largely by picking over old workings and dumps, and much of it consisted of small chips and poorer grade material. The scarcity of water in the opal field makes prospecting and mining very difficult. The industry might be stimulated by sinking wells or placing tanks at selected places.

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[a] Science, new ser., vol. 26, p. 380.
[b] Ann. Rept. Dept. Mines, New South Wales, 1908, p. 54.
[c] Min. Jour., London, Anniversary Number, August, 1909; also August 21 and September 18, 1909.
[d] Ann. Rept. Under Secretary of Mines, Queensland, 1908.

CANADA.

Fire opal is reported to have been found in British Columbia,[a] near Kamloop, in the bed and banks of Deadman's Creek. The gems are said to be similar to the Mexican fire opal.

PECTOLITE.

NEW JERSEY.

Mr. Frederick A. Canfield, of Dover, N. J., reports the finding of a few pounds of greenish-white pectolite at Paterson, N. J. This material is translucent, and some of it has been cut for gem purposes. Massive white pectolite was also found in the new Erie Railroad cut through Bergen Hill, N. J.

PERIDOT.

ARIZONA.

Peridot of gem quality has been found in two regions in Arizona. One of these is in the Navajo Indian Reservation, as described in this report for 1908. The other region is in the San Carlos or White Mountain Apache Indian Reservation, near Rice, or the old Talklai post-office, and 6 miles distant from Mesa. The production of peridot from these regions has declined during the last few years, so that there is but little annual production, and that reported comes in part from material collected several years ago. The decreased production is due to several causes, among which are overproduction, with a flooding of the market soon after the discovery; the occurrence of the deposits on Indian lands, so that they are only partly available to white people; lack of interest on the part of the Indians who once collected the gems; and the low prices offered by dealers. The demand for large peridot with good color remains, though there are stocks of the smaller-sized gems on hand for which there is not a good market. The material produced at present consists mostly of small sizes, since the more readily available peridots that would cut large gems have been carefully gathered up. It is probable that large gems of good color can still be obtained in either region mentioned, though labor and systematic work would be necessary. The greater part of the production has been through the Indians, who gather the loose peridot pebbles from the soil and wash formed by the disintegration of the rock matrix. Near Rice some gems of fine quality have been obtained, principally by white men, by blasting and breaking up the basaltic rock in which the gems occur. Large loose blocks and cliffs of the basalt have been blasted and the peridot worked out by hammer and chisel.

The post-office of Rice is in the Rice Indian school, and the station is on the Gila Valley, Globe, and Northern Railroad, about three-fourths of a mile to the south. The railroad approaches Rice from the southeast up San Carlos Creek and swings to the west near the station up a tributary of the creek. The school is in the main valley of San Carlos Creek. The valleys near Rice are from one-fourth of a

[a] Manufacturing Jeweler, February 17, 1910.

mile to over a mile wide and contain lands sufficiently level for irrigation and farming. In other parts there are numerous hills and terraces of gravel. The valleys have been cut through mesas and table-lands formed principally by basalt flows at different elevations. The first basalt-covered mesa is about 200 feet above the creeks and extends, rising with a gentle slope, from one-half mile to 3 miles back from them, where it is succeeded by higher plateaus or hills. This mesa is covered with the scoriaceous surface of a basalt flow, which forms malpais land on each side of the creek and between the forks. The elevation of Rice is 2,635 feet above sea level.

The peridot gems have been found principally in and along Peridot Canyon, which enters the railroad valley about one-fourth of a mile west of the station. Peridot Canyon drains to the northeast and is about 1⅓ miles long. It cuts back into a large area of malpais country on the first mesa south of the railroad, with a depth of about 25 feet at its head and 200 feet at the mouth. The canyon heads off with a small cliff, above which there is an arroyo leading back on the table-land. Peridot Canyon ranges in width from 50 yards at the upper end to 200 yards at the lower end between the cliffs forming its upper walls.

The most prominent rock of the region is the basalt, which forms the malpais-covered mesas. This basalt ranges from 25 to probably over 100 feet thick. At only a few places in the canyons do the underlying rocks outcrop. In the lower end of Peridot Canyon white to gray cross-bedded sandstone and tufaceous conglomerate outcrop under the basalt flow. These rocks are horizontal or only gently folded and are baked along the contact with the basalt. In many places the rocks underlying the basalt in the canyon or valley walls are concealed by a heavy talus of the basalt. The latter rock exhibits little or no sign of columnar jointing, but in places possesses a nearly horizontal sheetlike structure or bedding. It is vesicular to a marked degree in the upper part of the beds and less so in the lower part. The basalt is a normal grayish-black olivine basalt, in which there are inclusions of olivine or peridot of considerable size. In thin sections under the microscope the component minerals are seen to be labradorite, in small lath-shaped crystals; augite, with a brownish-violet color in small grains, laths, and aggregations of grains; olivine, in grains, crystals, and larger masses (peridot); and iron ore in numerous minute and occasional large grains and crystals. Many of the olivine grains are surrounded by a film of hematite stain. The texture of the basalt is medium grain for that rock, though the constituent minerals can not be distinguished without the use of a microscope. Besides inclusions of balls of peridot or olivine the basalt contains occasional small masses of black glass.

The peridot occurs in rounded, oval, semiangular, and angular-shaped balls and masses in the basalt. These inclusions range from a fraction of an inch to 8 or 10 inches in diameter and are very irregularly distributed through the rock. In some places they occur within an inch or two of one another through a large volume of basalt, and at others they are almost absent or separated by several feet of barren rock. These masses consist of granular olivine or peridot and diopside. They range in texture from grains as fine as those of ordinary sandstone to grains measuring an inch or more in diameter. These grains are rounded to subangular and angular and consist of individual crystals of olivine and diopside, which were prohibited from assuming crystal form by crowding. These inclusions are practically the same as small masses of peridotite and may represent fragments of that rock torn from masses underground, through which the basalt lava was forced. It is possible, also, that these inclusions of peridotite represent very basic segregations in the basalt lava, though their irregular distribution and abundance in certain places and their absence in other places do not indicate such an origin. The balls are composed principally of peridot. The diopside is less prominent and occurs in two shades of color, dark bottle green and emerald green. The diopside reacts for chromium and is chrome diopside. Few specimens, if any, of the diopside are obtained that are large enough to cut as gems. Among interesting specimens collected from the gravels of Peridot Canyon is a white to colorless crystal of albite, measuring roughly 1 inch square and three-fourths of an inch thick; the surface is somewhat etched.

In a large number of the peridotite inclusions in the basalt there are no olivine grains sufficiently large to cut as gems. In some portions of the basalt the peridotite inclusions, no matter how numerous, are all too fine-grained to be of value. In other places a good portion of these inclusions may contain gem material and several large clear gems along with smaller ones may be secured from a ball of 2 or 3 inches in diameter. Apparently good gem peridot was found in the largest quantity in the upper part and near the head of Peridot Canyon, for this is the place where the greatest amount of work has been done. In places there are joints and seams cutting the basalt, along which there has been more or less weathering. The rock along these seams can be easily worked, and good gem material is sometimes secured. In other places the fresh hard basalt is blasted and broken up in search of gems. As a general rule the peridotite masses crumble readily as the inclosing basalt is broken away, so that the gems are easily picked out without more fracturing than that caused by blasting. Occasionally nearly solid crystals of gem peridot of the size of an English walnut are inclosed in basalt with little or no granular olivine around them. It is almost impossible to free such crystals from their matrix without fracturing badly. In breaking up the basalt and the included peridotite rough gems ranging from small size to as large as a pecan nut were obtained. The principal yield is in pieces that when cut up would weigh between 1 and 3 carats. Larger stones are not uncommon.

The rough peridot broken from the fresh rock is brilliant and clear. That obtained along seams is apt to be etched or stained on the surface, though clear and of good color within. Pebbles gathered from the canyon gravels or over the mesa country also have dull and more or less stained surfaces.

It is said large quantities of peridot, liberated by the disintegration of the inclosing rock, have been gathered by the Indians from over the mesa country and from the gravels of Peridot Canyon. If such is the case, the loose gems must have been gathered up with great care, for few of them are now left on the mesas. A few peridots sufficiently large to cut may still be found in the gravels of Peridot Canyon and in places the olivine sand is gathered into hills by the ants as described in the Navajo region. The earlier supply of peridot from this region placed on the market consisted of crystals or masses with dull surfaces, such as is still found loose in the soils and gravels. Since the best gem material now has to be broken from the rock it may be recognized by the bright surfaces of the fresh fractures. Unless a new locality where loose peridots can be gathered from the surface is found, the supply from this region will have to be obtained by blasting the basalt and carefully chiseling out the gems.

Gem peridots have also been found in the adjoining canyons southeast and northwest of Peridot Canyon, and in the basalt-capped mesa a few hundred yards north of the Indian school. They are not plentiful in these places, and the number of peridotite inclusions in the basalt is very small. Peridotite inclusions in basalt were found a little over 1½ miles west of Rice, along the railroad. A few of these seemed to give promise of the occurrence of gems at that locality. Another reported locality is over a mile southeast of the Indian school, across the San Carlos Creek.

The best gem peridots from the Rice locality are of about the same color and quality as those from the Navajo Reservation. It is probable the yield of good gem material from equal amounts of rough, unselected peridots is much larger in the Apache fields than in the Navajo fields. Peridots from the latter region contain a larger proportion of brownish-green stones than those from the Rice locality. The brown color of the Navajo peridot is caused by numerous microscopic brownish inclusions of six-sided plates of mineral, while in the Apache stones the brownish-green is apparently due to the natural color of the stone. Inclusions of small black specks and cavities or flaws occur in the Apache peridots in sufficient quantity to ruin them as gems in some cases. The beautiful light-yellowish green and richer green colors so much admired in peridot are present in many of the gems.

PHENACITE.

COLORADO.

In operating the aquamarine deposits on Mount Antero, Colo., Mr. J. D. Endicott, of Canon City, has obtained some phenacite crystals suitable for gem and specimen purposes.

QUARTZ.

OKLAHOMA.

Mr. Oliver Powers, of Lawton, Okla., has furnished the following note on quartz from the Wichita Mountains, Okla.: Some years ago there was considerable interest in "Wichita diamonds" and several people in the region sent specimens away for cutting. A number of the cut stones were very clear and of good luster, and part may have been topaz which is reported to have been found in this region. When it was found that the crystals were not diamonds the interest in them subsided. A more interesting variety of the quartz is that inclosing fine needles of silvery white and golden colors. The latter may be rutilated quartz. This hairstone has been cut and used locally for jewelry.

COLORADO.

Mr. W. C. Hart, of Manitou Springs, Colo., reports a production of about 1,000 pounds of smoky quartz from the west side of Pikes Peak, Colo. The smoky quartz occurs in crystals up to 10 and 15 pounds in weight. The exterior of the crystals is coated with a layer of cloudy to opaque quartz. The interior is composed of dark smoky brown clear quartz of fine cutting quality. Mr. Hart has on exhibition faceted gems cut from this quartz that measure nearly 2 inches across.

ROSE QUARTZ.

NEW YORK.

An asteriated variety of rose quartz has been described by James G. Manchester.[a] The description is illustrated by a photograph which shows a six-ray star very plainly in a sphere 18 millimeters in diameter cut from the rose quartz. This rose quartz has a delicate rose tint and is quite translucent. The star is seen only in spheres of the rose quartz by transmitted light. This asteriated rose quartz is found at the Kinkle and the Hobby quarries in the towns of Bedford and North Castle, respectively. These quarries have been described by Edson S. Bastin.[b] Mr. Manchester states that a sphere cut from rose quartz from Maine does not show the asteria effect, while that from California and Brazil exhibit it only by reflected light. No satisfactory explanation has been offered as to the cause of asterism in rose quartz.

TOURMALINATED QUARTZ.

NEVADA.

Mr. R. C. Hills, of Denver, Colo., reports the occurrence of fine tourmaline needles in glassy quartz near the hübnerite tungsten deposits at Osceola, Nev. This material comes from a new locality discovered by George Doyle, of Osceola.

RHODONITE.

CALIFORNIA.

A deposit of beautiful rhodonite for gem purposes has been located in the Happy Camp mining district, Siskiyou County, Cal. This deposit is about 6 miles east of the californite locality and high up in the mountains. It is owned by Cyrus Wheeler, of Los Angeles, and the output of the gem has been handled by the Southwest Turquoise Company of the same city. This rhodonite has the most delicate tints of pale to dark rose-pink. Much of it is marked by seams of black manganese oxide, which form a beautiful contrast with the rhodonite. A description of the locality will be given in this report for 1910.

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[a] Asteriated rose quartz in New York: Min. World, June 11, 1910, pp. 1185–1186.

[b] Contributions to economic geology, 1906: Bull. U. S. Geol. Survey No. 315, pt. 1, 1907, pp. 394–399, and feldspar deposits of the United States: Bull. U. S. Geol. Survey No. 420, 1910, pp. 60–63.

NEW JERSEY.

Prof. John E. Wolff, of Harvard University, and Mr. Wallace Goold Levison, of New York, report some semitransparent rhodonites of very beautiful pink color from the Franklin Furnace region, New Jersey. These crystals came from the Parker shaft. Mr. Frederick A. Canfield, of Dover, N. J., states that a small quantity of fowlerite or zinc rhodonite, from this region, found in 1909, was suitable for cutting into small gems. These had a rich red color. Some larger crystals with superior color were also found.

RUBY.

BURMA.

According to E. A. Wakefield,[a] of Rangoon, there are four principal ruby mines in the Mogok Valley, Burma, with smaller workings in the adjacent valleys. In the four larger mines modern machinery and methods are used in mining and washing for rubies; the smaller mines are operated by the natives with hand labor. The results obtained by the latter are sometimes surprisingly good. In the larger mines the overburden or "byon" is first removed to the ruby-bearing clay. The clay is dug up and carried by trolleys to steam cleansing mills, where it is washed through sieves and examined for ruby and spinels. It is not often difficult for the expert to distinguish between the real ruby and the balas ruby or spinel. The mining interests are very liberal with the natives and provide good quarters for their employees. The town of Mogok is located on rich gem-bearing ground and is being removed as operations progress. As the quarters for the natives are removed comfortable new ones are supplied.

SAPPHIRE.

QUEENSLAND.

The production of sapphire for gem and mechanical purposes in Queensland [b] during 1908 is estimated at £15,200, as compared with £40,500 in 1907. The production of gem sapphire was £11,800. The large decrease was doubtless caused by overstocking the market during a period of dull trade, especially in Russia, where the Queensland sapphires are much used. During 1909 sapphires estimated as valued at £17,320 are thought to have been sold locally by the miners.[c] The Queensland sapphires do not bring so high a price as many of the sapphires from other countries, being considered of inferior grade. Many of these sapphires are cut in Germany, though a few are cut locally.

CEYLON.

Mr. Edward A. Sweet, 12 Spencer Court, Brooklyn, N. Y., obtained one of the largest known sapphire crystals from Ceylon during 1909. The crystal weighs 10 pound 6 ounces troy, and is approximately 7½ inches long by 3½ to 4 inches thick. It has been slightly water worn and has a grayish color. The crystal was obtained for cutting up for mechanical use, but it is hoped that it may be saved for some collection.

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[a] Daily Cons. Repts., July 26, 1909, No. 3541.
[b] Ann. Rept. Under Secretary of Mines, Queensland, 1908.
[c] Australian Min. Standard, February 9, 1910.

TOURMALINE.

MAINE.

During the year 1910 a new deposit of tourmaline was opened on the land of F. L. Havey, near Poland, Me. The deposit is on land adjoining the Berry property, where feldspar and tourmaline have been mined. Mr. George R. Howe, of Norway, Me., with the permission of Mr. Havey, has kindly furnished notes on the tourmaline taken from the mine during the time of operation from July to October, 1910. The features of these tourmalines are the predominance of green and the fine quality and clearness of the gem material. Some fine rich blue (locally called "Alice blue") tourmaline is also obtained. Rubellite and achroite terminations are present on both the green and the blue crystals. Yellowish-green and yellow colors also occur. Some crystals (locally called "watermelon" crystals) have pink centers and green margins. Of a representative collection containing 108 crystals, chosen from the output of the mine, 98 crystals are of gem quality and weigh 3,231 carats. It is estimated that this should yield 1,000 carats of cut gems.

CALIFORNIA.

The trade with Chinese merchants in pink tourmaline from California has grown to a considerable industry. According to Mr. Harry E. Dougherty, of Hemet, Cal., the Chinese market called for all grades and sizes in the early stages of the trade, but the demand is now only for larger crystals and medium dark pink gems. Pale colors and reddish-pink gems are not wanted. The checked and flawed tourmaline, such as is cut "en cabochon," is desired and not the high-priced flawless gems. The greatest demand is for pieces from an inch and a half in thickness to the largest sizes obtainable. The tourmaline is supposed to be used in beads and other jewelry, and in the case of larger crystals a core is taken out and the shell is polished and used as a tube to dress the hair with. Prices up to $150 per pound avoirdupois are paid for suitable material. Mr. Dougherty estimates the value of the purchases by the Chinese during 1909 to be close to $100,000.

A large sale of tourmaline by L. Tannenbaum, of the Himalaya Mining Company,[a] of New York, to a Chinese merchant is reported to have been made during the summer of 1910. This consisted of 358,500 carats of pink tourmaline crystals ranging in size from 100 to 1,000 carats.

TURQUOISE.

DEPOSITS AND MINING.

Turquoise deposits have been tested or worked in the following States: Arizona, California, Colorado, Nevada, New Mexico, and Texas. The largest production has come from the mines of New Mexico, Arizona, California, and Nevada. The quality of the gem material from the different States and from the different mines in the same State varies greatly. The finest gem material has probably

[a] Jewelers' Circ. Weekly, August 3, 1910.

come from some of the mines of New Mexico and Nevada. The turquoise mines of New Mexico were the first to receive attention, and the output from this Territory has exceeded in value that of any State. A large number of the turquoise deposits so far found in the Southwest were worked by the ancient Aztecs, and a few by the Aztecs under Spanish rule. Many of the deposits have been located by opening these old mines or prospecting around them..

The turquoise deposits of the different States have many points of resemblance. The occurrence is nearly always in arid, if not desert, regions of considerable elevation. The operation of the deposits is therefore often attended by hardships, due to excessive temperatures with extreme temperature changes, high winds, lack of water, and difficulty of securing wholesome food. The prospector is beset with the same or greater difficulties, since his equipment is often limited, and therefore the location of new deposits requires patience and endurance. The occurrence of turquoise is generally in or near such igneous or volcanic rocks as granite, quartz or monzonite porphyry, and rhyolite or trachyte. These rocks are generally more or less altered, and it seems to be due to this alteration that it has been possible for the turquoise to form. The common form of alteration near the turquoise deposits is sericitization or kaolinization, either or both. Some of the turquoise mines are in regions where large copper mines have been discovered. Copper prospects have been found near other deposits, and generally indications of copper near turquoise deposits are readily seen.

To appreciate the difficulties encountered in locating and operating turquoise mines, one must see the prospector or miner in the desert regions. A few of the mines are fairly well provided with water and transportation facilities, so that comforts may be obtained.

At many mines the water supply for the camp for all purposes must be hauled in barrels from 1 to 15 miles, and at some mines it has been necessary to haul water 30 miles or more. The difficulties of mining account for the large number of partly prospected deposits lying idle in many parts of the Southwest. Mines known to contain good turquoise in quantity are not worked because they are in regions too difficult of access.

ARIZONA.

The principal turquoise mining region of Arizona is near Mineral Park, in Mohave County. The mines at this locality were described in this report for 1908. Of the several companies operating at that time all continued work during part, at least, of 1909. Turquoise has been mined in the Gleason district, in Cochise County. Turquoise of fair quality is reported to have been obtained from some of the mines of this district when operated a few years ago.

CALIFORNIA.

The principal turquoise mines of California are in the northeastern part of San Bernardino County, nearly 100 miles north of the Needles.[a] These deposits were operated by the Aztecs, and many signs and inscriptions of these people have been found on the rock.

[a] Kunz, G. F., Gems, jewelers' materials, and ornamental stones of California: Bull. California State Min. Bureau No. 37, 1905, pp. 107–110 and 152–153.

The principal operators in this region in recent times have been the Himalaya Mining Company and the Toltec Gem Mining Company. The properties of these companies are about 6 miles apart and have not been operated for several years.

More recent mining for turquoise has been carried on farther south in San Bernardino County, near Cottonwood siding on the Santa Fe Railroad.

Gove turquoise mine.—The Gove turquoise mine is in the Mohave desert, about 2 miles west of Cottonwood siding, on the Santa Fe Railroad, in San Bernardino County. It was operated during 1908 by C. A. Gove, of the California Gem Company, of Los Angeles. The mine is in a low ridge which slopes gently down to the sand flats along Mohave River on the east and northeast. The deposit has been opened by two shafts, about 20 and 30 feet deep, respectively, with a little drifting, some crosscut trenches, and several small pits. These workings are all within a distance of 150 yards in a northeast-southwest direction.

The country rock is principally a fine-grained, dark-gray biotite gneiss or graywacke, which strikes N. 30° E. with a nearly vertical westerly dip. In thin section under the microscope the constituent minerals are found to be biotite, with a yellowish to brownish green pleochroism, and quartz. The biotite occurs in laths and plates with a rough parallel orientation. The quartz grains are small and rounded to angular. The graywacke is cut by a belt of schistose rhyolite or fine porphyry, about 100 yards wide. This porphyry has been squeezed and partly altered to a sericite schist. The constituent minerals determined in thin section are muscovite or sericite, quartz, and orthoclase. The texture of the original rock was very fine grained, and portions of this texture are preserved, though with a schistose structure. There has been a partial decomposition and kaolinization, with a consequent liberation of free silica, which has been deposited in seams and fractures through the rock.

The turquoise occurs along the contact of the graywacke and the rhyolite. This contact is rather irregular, and the turquoise has been deposited in both formations. Seams of limonite fill numerous joints and fractures in each rock, and stains of iron oxide have worked along the schistosity of each. Turquoise occurs in seams and nuggets in each rock and is generally associated with the limonite in the graywacke. In the rhyolite the turquoise is sometimes found with quartz or with stains of limonite. The nuggets of turquoise have developed along limonite seams, in fracture zones, and apparently in hard rock also; they range from a fraction of an inch to over an inch in thickness, and most of them are elongated in the direction of the schistosity of the rock. The nuggets are fairly plentiful in a few places in the shafts and the tunnels. The seams of turquoise cut the rock in various directions and are not often large enough to yield gem material. Many of the nuggets are pale and rather too soft for cutting; some of them, however, have a good blue color and the usual hardness. The turquoise from the graywacke is in general of much better grade than that from the rhyolite. The best turquoise from the Gove mine has a rather light to medium dark, pure blue color. The lighter blue may be called "baby blue." The principal value of the production is in the pure blue turquoise, though the yield is not large.

In a copper prospect opened 150 yards northwest of the turquoise mine a 6-inch vein of dark-gray quartz with stains and seams of blue chryscolla and green malachite has been found. This material might serve for cutting into cheap copper-ore gems. About a mile southwest of this prospect similar material was found associated with pyrrhotite and chalcopyrite.

COLORADO.

The mine of the Colorado Turquoise Mining Company, 13 miles S. 60° E. of La Jara, Comejos County, has been leased by C. G. King, of Manassa, Colo., and C. H. Wyman and H. E. James, of Colorado Springs, who set up a polishing plant at Colorado Springs and cut turquoise during the last part of 1909 and were operating during the first part of 1910. The mine was described in this report for 1908. Handsome matrix is obtained with dark to light-blue and greenish-blue turquoise, mottled with brown iron stains and seams of limonite.

NEVADA.

The turquoise mines in Nevada have been exploited more recently than in the other States mentioned. There are two principal regions, the Esmeralda-Nye County region and the Searchlight district in Lincoln County. The mines of the Esmeralda-Nye County region have been the most productive, and some of them are in operation at present. Turquoise has been found at numerous points within 25 miles of the Goldfield Railroad, between Sodaville and Goldfield, in both Esmeralda and Nye counties. Other deposits have been found to the north, near Yerington, in Lyon County. Some of the deposits are more or less closely associated with variscite, which mineral has been mistaken for turquoise by some of the prospectors. The quality of some of the turquoise from this part of Nevada is especially fine in both color and hardness.

Royal Blue turquoise mine.—The Royal Blue mine of the Himalaya Mining Company is in Nye County, Nev., 12½ miles N. 12° W. of Millers, and nearly 7 miles northeast of Crow Springs. The mine was owned and operated for a number of years by William Petry, of Los Angeles, and was sold to the Himalaya Mining Company in 1907. During 1908 and 1909 the property was systematically and actively worked under the direction of Julius Goldsmith for the Himalaya Mining Company. There are four claims at the main part of the mine and three others in the region.

These deposits are located among the hills on the eastern scarp of a plateau lying north and northeast of Crow Springs on the west side of Big Smoky Valley. The Royal Blue mine is about 5,400 feet above sea level, on a ridge extending west from a knob about 100 feet higher. The mine has been worked by 5 tunnels, 3 shafts, 3 open cuts, and some smaller pits. At the time of visit the tunnels were about 200, 115, 30, 30, and 20 feet long, respectively; the shafts were 20, 35, and 40 feet deep, respectively; and the open cuts were from 15 feet to 60 feet long, 25 feet wide, and 40 feet deep. The 200-foot tunnel was driven in from the hillside on the north to the main open cut at a depth of about 25 feet and was used to remove much of the rock from the open cut. There have been about 100 feet of crosscut tunnels driven from this 200-foot tunnel, one of the crosscuts connecting with a shaft. A raise was being made at the time of examination from the 200-foot tunnel to a pit on the surface above. The 115-foot tunnel was driven in from the northwest below the bottom of the 40-foot open cut, with which it connected by a chute. Two 30-foot tunnels and an open cut 20 feet square were made on the south slope of the ridge near the top and 80 to 100 yards southeast and east of the main open cut. A track with mine car was used in the 200-foot tunnel to remove waste, though the track was to be moved to the 112-foot tunnel.

The country rock is a fine-grained light-colored porphyry, which appears, under the microscope, to be an altered trachyte. The original feldspar crystals have been crushed and largely altered to sericite, and in places to kaolin. A few small scattered grains of quartz occur through the altered feldspars. These sericitized feldspars are inclosed in a very fine feldspathic groundmass, also partly altered. The thin section contains numerous square or rectangular holes surrounded by or partly filled with much limonite stains, evidently the remains of original pyrite crystals now weathered away. The decomposed trachyte is soft in places, but much of it has been hardened by silicification and by a ferruginous cement. Where free from iron stains the trachyte is light-gray to white, though much of it is stained brown by limonite along seams and through the rock. The rocks of the region have been badly broken and shattered with many resulting joints and fissures, which are now filled with quartz, limonite, and occasionally turquoise. Ledges of dense hard gray quartz, locally called "bull quartz" and resembling quartzite, outcrop over the country, especially on the ridges and hilltops. These ledges strike in various directions. Under the microscope this rock appears to be an altered phase of trachyte thoroughly impregnated with quartz or a highly silicified phase of the trachyte. Limonite stains are common in seams and through this "bull quartz." The same rock is found in smaller masses in the ground worked for turquoise. A few hundred yards west of the turquoise workings is an outcrop of a conglomerate-breccia stained green with malachite.

The turquoise occurs principally in seams and veinlets with an occasional lenticular or nodular structure and in nodules or irregular lumps in the rock. The veinlets and lenses range in size from a small fraction of an inch to over an inch in thickness; the nodules from small lumps to those an inch or two in thickness. Masses of turquoise filling brecciated matrix have been found 4 or 5 inches thick. Lens-shaped pieces of turquoise weighing an ounce or two are not uncommon, and one piece weighing nearly a pound and a half was reported. The turquoise varies in color from dark sky blue to pale blue. Some of the dark blue has a greenish cast and some has a nearly pure blue color. The dark-blue turquoise and that with a greenish cast is very dense grained and very hard. The lighter-colored variety is generally softer. The best hard turquoise is generally found in the harder limonite-stained rock, and the pale blue and softer turquoise is found in the light-colored soft trachyte. The quality of the best pure blue turquoise from the Royal Blue mine is probably equal to that of any other American turquoise, and the matrix from this mine is also especially fine. The hard turquoise veins and nuggets are coated with a crust or stain of dark to light brown and yellow limonite. This stain also penetrates the turquoise at intervals along seams and branching cracks, producing most attractive patterns and contrasts of color. A large specimen examined and photographed at the mine measured about 8 by 3 by 2 inches. This specimen consisted of a patchwork of dark-blue turquoise with a slight greenish tint in places in a very dark red-brown matrix. The cut gems from such a specimen should show splendid contrasts in mottled or turtle-back matrix.

The cut gems vary with the nature of the turquoise. The combinations of pattern and contrasts in colors exhibited by some of the matrix stones are very beautiful. One especially attractive set of colors consists of seams and splotches of light-brown and dark-brown matrix with an irregular fringe of dark-blue or sometimes slightly greenish-blue turquoise filled in with pale or baby blue turquise. In some specimens the brown matrix or darker blue turquoise assume a dendritic or bushy appearance in the lighter blue. The mine has yielded to both operators a large quantity of such gem material as described. Among polished gems from this mine seen in William Petry's office were slices 2 to 3 inches across and weighing 50 to 100 carats, for belt buckles, large brooches, parasol handles, and many smaller gems, all beautifully marked and colored. The better grade of matrix is retailed at $1 per carat.

Oscar Wehrend prospect.—Oscar Wehrend has tested a prospect about one-third of a mile north of the Royal Blue mine, across a draw. At the time of visit (August, 1909), there were two open cuts, 20 to 30 feet long, with a maximum depth of 12 to 15 feet. An old shaft near by, about 30 feet deep, had not been cleaned out. The country rock is trachyte badly altered and decomposed. It has been kaolinized without being much silicified or hardened by iron oxides. The loose rock thrown on the dump has slaked badly in the weather. "Bull quartz" ledges outcrop on the hillside above. The turquoise occurs through the rock, in seams, splotches, and nodules, which reach a thickness of 2 inches or more in places. The turquoise is mostly quite pale and rather soft, and further prospecting has not developed a much better grade of material. This turquoise is susceptible of having the color improved by artificial means, as during the process the turquoise becomes somewhat hardened and would serve for cheap grades of jewelry.

William Petry turquoise mine.—The William Petry turquoise mine is about three-fourths of a mile south of Crow Spring and 10½ miles N. 40° W. of Millers, Esmeralda County. The mine is in the summit of a small knob among the foothills on the east side of the Monte Cristo Mountains and about 200 to 300 feet above the lower country on the east or between 5,400 and 5,500 feet above sea level. The work has been more in the nature of prospecting than mining and consists of three small pits, one each on the east, north, and west sides near the summit of the hill. The cut on the north side is 50 feet long in a southerly direction, is 3 feet wide, and grades to 15 feet deep.

The hill is composed of very fine-grained porphyry or rhyolite, probably a portion of a flow extending back into the Monte Christo Mountains. Regular granite porphyry outcrops on the northeast side of the hill below the mine and may represent a coarser-grained phase in the interior of the porphyry flow. Hard ledges of silicified porphyry outcrop over the hill in a northeast direction. The chief constituents of the porphyry as determined in thin section are quartz and orthoclase with small amounts of epidote and zircon. The thin section contained many small holes such as might have formed where stout apatite crystals had been decomposed or ground out. Around the edges of some of these holes were small rims or patches of a mineral with a low birefringence and fairly high refractive index which were probably apatite. The section was cut from a fairly fresh specimen of the rock, though it contained a few clouds of kaolin and was traversed by several small seams of turquoise. Other portions of the porphyry on the hill are extensively altered and kaolinized and some are stained pinkish. The decomposed porphyry is somewhat silicified in places and stained with iron oxides.

The turquoise occurs in seams cutting the porphyry at all angles. Seams ranging from paper thickness to nearly half an inch thick were seen. In some places there are several seams in the space of an inch more or less parallel with one another or branching out or cutting across one another. In some cases the porphyry matrix is very fine grained and hardened by a siliceous or ferruginous cement. Such material cut by turquoise seams an eighth of an inch thick is especially adapted for cutting into cameos, and much of it has been used for that purpose. The turquoise ranges from pale blue to pure blue of a fairly dark color. Material that would yield gems of large size is scarce, though the best blue stones have a good color and are very hard. Some pretty turquoise matrix with brown and red markings are obtained.

Another prospect is reported to have been opened by William Petry and Oscar Wehrend, about a third of a mile to the northwest at the foot of another knob, where, it is said, more turquoise of good color and of more promising size was found.

Myers and Bona turquoise mine.—H. M. Myers and Charles A. Bona, of Millers, Nev., leased and worked a turquoise prospect on the Gilbert-Thompson property, 13 miles north of west of Millers, Esmeralda County. The mine is on the western slope of the eastern part of the Monte Cristo Mountains at an elevation of about 6,400 feet. The principal work was for gold and copper, for which the mine was opened, the turquoise being found later. The workings consist of a shaft 40 feet deep, a tunnel 75 feet long, with about 40 feet of drifts and stopes from it, an open cut near the shaft, and a few prospect pits. The mine is in the northeast face of a small steep hill.

The country rock is principally quartz porphyry, which incloses bands of black slate. The porphyry is strongly altered, the feldspar having changed almost entirely to sericite. In this section the quartz phenocrysts are seen to be badly crushed and shattered and inclosed in a mass of fibrous sericite. The black slate has slightly calcareous and siliceous phases, and part might be classed as jasperoid. Some of the black slate is soft and resembles graphitic phyllite.

The turquoise is found along the contact of the porphyry with a band of included slate. This body of slate strikes about N. 20° W. and has an irregular dip of 30° to 50° SW., and a ledge of silicified rock with a prominent hard outcrop cuts across it at right angles. The slate contacts and inclusions in the porphyry appear to be baked in places and to have altered and become soft in other places. The turquoise occurs in nodules and nodular seams or veinlets. The nodules range from a fraction of an inch to over 2 inches in thickness and the seams up to one-half inch in thickness. The seams of turquoise are not regular or continuous, but pinch and swell from small size into nodular lumps; some of the nodules of turquoise are scattered through the rock irregularly, while others occur in a lead inclosed in a softer gouge-like matrix. The best turquoise occurs in the black slate, generally in the softer decomposed streaks; some is found in the porphyry, but it is generally soft and not of good color.

The turquoise from this mine presents some peculiar features. The best material is hard and is a beautiful sky blue in color. Some specimens of the hard turquoise have also a greenish cast with the sky blue. Many of the nuggets, especially the larger ones, are pale blue and are deficient in hardness. These nuggets are very tough, however, and are difficult to break with a hammer. They appear to have a very fine felty fibrous texture, slightly resembling meerschaum, even when examined under the microscope. Iron stains are present with some of the turquoise, either along the walls of the seams or filling cracks in the mineral, and they add to the beauty of the matrix material.

The best turquoise from this mine is probably equal in color and hardness to turquoise from many mines in the Southwest. The output of the deep-blue turquoise is not large, compared with the poorer grades, and large specimens are scarce. Round balls of hard white mineral, having a fine texture and ranging up to 4 inches in diameter, occur through the porphyry. This material is a hydrous phosphate of aluminum, though its exact composition has not been determined. In texture and appearance it resembles white turquoise. The mine was worked during 1908, but was not operated in 1909 because of the trouble experienced in placing the gem material on the market.

Montezuma turquoise mine.—The Montezuma mine of the German American Turquoise Company is 12 miles N. 40° E. of Redlich, and about 20 miles by road east of Sodaville, in Esmeralda County. It is in the foothills on the east side of the Pilot Mountains, at an elevation of about 5,900 feet above sea and 600 feet above a large sand flat about 2 miles to the east. The deposit is in the north side of a small hill and has been opened by about a dozen pits and tunnels of irregular shape. Other croppings of turquoise have been found on the hill, but have not been opened.

The country rock is soft decomposed porphyry, probably trachyte. Andesite and traplike rocks outcrop in the region. Ledges of quartz or hard silicified porphyry also outcrop across the hill and in the surrounding country; many of them have a northeast strike and vary from a few feet to 15 feet in thickness; others cut the country rock at various angles. These porphyry and quartz ledges have been crushed and the joints filled in with brown to purplish stains of iron oxide. The turquoise occurs in the altered trachyte in seams, veinlets, and nodules which range up to an inch or more in thickness. The turquoise is quite variable in color and hardness, and ranges from hard, very fine dark blue to dark blue with a greenish cast to pale blue and soft material. There is much dark brown to yellow limonite stain associated with and filling fractures in the turquoise.

The best colors and the hardest stones are generally found in the hard iron-stained portions of the trachyte, and the softer pale-blue stones in the light-colored soft porphyry or trachyte. The best cut matrix gems from this mine resemble those from the Royal Blue mine in marking and color. Strong contrasts in brown and blue, with mottled patterns are obtained and yield beautiful gems. The bulk of the output is in low-grade gems which are retailed at about 50 cents per carat.

Moqui-Aztec turquoise mine.—The Moqui-Aztec mine, or the S. Simmons turquoise mine, is about a mile southwest of the German-American mine in the south side of a ridge at an elevation of about 6,250 feet above sea level or 350 feet above the valley below. The mine has not been operated since 1908 and the workings have fallen in so badly that a thorough examination was not possible. There were three or four tunnels, one of them 80 feet long, with irregular open cuts and pits. One of the tunnels was driven in from the opposite side of the ridge about 100 yards to the northeast of the mine workings. The 80-foot tunnel was driven N. 35° E. (magnetic) and apparently along a turquoise lead.

The country rock is rather fine-grained quartz porphyry, approaching granite porphyry, badly decomposed and kaolinized. Irregular masses of quartz outcrop on the hillside in and near the mine. Portions of the porphyry are stained with iron oxides, and the quartz is badly iron-stained. The turquoise occurs in veinlets and nodules in the porphyry and quartz, and that associated with limonite iron stains is generally the best in grade. A large amount of pale-blue turquoise has been obtained from this mine and cut at the owner's lapidary shop in Los Angeles. Turquoise of dark pure blue color is scarce and some of the paler variety is deficient in hardness. Pretty light-blue matrix stones with delicate brown markings have been cut in some quantity.

Smith black matrix turquoise mine.—The Smith black matrix turquoise mine is about half a mile south of the Southern Klondike mining camp and about 3 miles northeast of Klondike, a station with water tank on the railroad between Tonapah and Goldfield, in Esmeralda County. The mine is in a group of small hills, about 400 feet higher than the railroad, or about 5,500 feet above sea level. A conical-shaped knob one-third of a mile west of the mine has an elevation of about 5,800 feet and is quite prominent because of its white color and elevation. The workings at this mine are small and consists of three small cuts with a short tunnel on the northeast slope of a hill of dark rock.

The country rock consists of limestone and shales, with hard siliceous phases called jasperoid by S. H. Ball [a] and classified as of Cambrian age. The limestone is a dark gray and grades into jasperoid and slate. The latter rocks are fine-grained, gray to black, banded rock, with a more or less wavy bedding. The hardness varies with the extent of silicification. A few hundred yards to the south of the deposit is a mass of rhyolite, with quartz porphyry phases, whose northern boundary extends in an irregular east-west direction. This mass appears to be a flow, and probably once covered the turquoise deposits and surrounding rock. It has a very fine grain and contains phenocrysts of orthoclase and quartz. Near the lower contact there are frequent inclusions of other rocks. This rhyolite has been partly weathered in places and assumes a pinkish color. The general appearance of the country over the rhyolite formation

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[a] A geological reconnaissance in southwestern Nevada and eastern California; Bull U. S. Geol. Survey No. 308, 1907, p. 77.

is light gray to white and is in marked contrast to the dark appearance of the limestone and jasperoid.

The turquoise occurs in seams and veinlets filling joints and fractures in black slaty jasperoid, which they cut at all angles. In places the jasperoid rock is badly brecciated, and here the turquoise fills in the spaces between the angular fragments. The seams range from the thickness of a sheet of paper to more than three-fourths of an inch. The brecciated masses with turquoise fillings may be an inch or two across. The thicker seams of turquoise generally contain angular fragments of black jasperoid. The turquoise seams, however, are very irregular in size and direction, and they branch from one joint plane to another at various angles. There is more or less limonite iron stain in the joints and through the rock, being in some places intimately associated with the turquoise.

The turquoise from this mine, little, if any, of which is sufficiently large to be cut into pure turquoise gems, has been handled by the California Gem Company, of Los Angeles. The output is entirely in matrix, which owes its beauty to the striking contrast between the blue turquoise and the black matrix in the innumerable patterns exhibited by them. In some of the cut stones the turquoise predominates, in others the black matrix. Some gems are cut with one or more seams or veinlets in matrix, others with fragments of matrix included in turquoise, and still others consist of badly brecciated matrix with a filling of turquoise. Brown iron stains are present in some of the gems and lend contrast. In other stones there are patches or seams of gray quartz, which blends well with the other colors.

The turquoise ranges from blue of a fairly pure color to very light blue to greenish. The greenish turquoise is difficult to distinguish from variscite in places, and may occur in seams in the same hand specimen with blue turquoise. The greenish variety does not react so readily for copper when tested by the flame coloration method, and some of it appears to contain very little of that metal. Under the microscope such material exhibits a texture resembling that of variscite—that is, it is concretionary and spherulitic—but it also appears to grade into a normal turquoise. It seems possible that there may be a gradation from turquoise to variscite through a more or less amorphous series of hydrous aluminum phosphates in which copper occurs in amounts varying from nothing to the several per cent necessary to produce normal turquoise. In this occurrence of turquoise the mother rock is similar to that in which some of the variscite is generally found, though there is the usual porphyritic rock characteristic of turquoise in the neighborhood, and it may have once covered the deposit of turquoise. Under such conditions the materials forming the turquoise could have leached from the porphyry during its decomposition into the broken jasperoid below. The copper necessary to supply the color of the turquoise may have come from copper minerals in the porphyry or from deposits in the jasperoid, in which a few copper stains were observed in one prospect near the turquoise mine.

Los Angeles Gem Company.—Turquoise has been found at two places on the variscite claims of the Los Angeles Gem Company, about 2 miles northwest of the deserted mining camp, Columbus, in Esmeralda County. One of these is at the west end of the group of claims on the Pirate No. 3 claim, and the other is a small knob about one-fourth of a mile south of the center of the line of claims. The rock formations and the general region are described under variscite in this report. In the first deposit mentioned a pit 5 feet deep and 15 feet long has been made in an east-west direction, following a seam of turquoise more than an inch thick a short distance in dark-gray cherty siliceous rhyolite. Part of this turquoise is fairly dark blue and quite hard. A little greenish variscite-like material was found in the same pit and is said to have come from the same veinlet as the turquoise.

At the other place two prospect pits were made in a dark jasperoid or silicified calcareous rock. Small seams of dark blue very hard turquoise with a slight greenish cast were found. These seams were not abundant, and none over half an inch thick were found, the majority being less than one-fourth of an inch in thickness. The very dark brown and black matrix with this turquoise would yield beautiful gems.

Little has been done with either of these prospects, as the company has been kept busy supplying the trade with variscite.

Other localities.—Turquoise has been found associated with variscite at other localities in Nevada. Among these are the claims of Carl Riek and W. K. Botts, 5 miles northeast of Coaldale, and of Clyde Carr and Mrs. Mattie Lovejoy, about 10 miles north of Blair Junction, both in Esmeralda County. Only a limited amount of work has been done on these deposits, though part of the turquoise found at each locality has a fine blue color. These deposits were visited in the spring of 1910 and will be described in the report for that year.

Turquoise was mined in Nevada during 1909 by Otto Taubert, 8 miles N. 75° W. of Yerington, in Lyon County. This mine was visited in May, 1910, and will be described in the report for that year. The turquoise occurs principally in seams and is a very hard variety. Some of it is a fine dark pure blue, and other is slightly greenish. Paler colors also occur, and much very pretty iron-stained matrix.

A collection of cut turquoise matrix from Belmont, Nye County, was examined in the office of William Kley, of Denver. This turquoise was obtained from Mrs. Eva S. Weber, of Belmont. The best grade consisted of dark-blue turquoise with a small amount of white mineral in a dark-gray and chocolate-colored matrix. The white mineral occurs as a fringe around the turquoise in many specimens and sets the turquoise with its chocolate-colored matrix off very beautifully. Along with this new variety of turquoise matrix was a larger quantity of ordinary blue, greenish, and brown matrix.

NEW MEXICO.

Turquoise has been mined in four regions in New Mexico. These are the Cerillos district in Santa Fe County, the Little Burro Mountains and the Little Hachita Mountains in Grant County; and the Las Cruces region in Dona Ana County. The best known of these localities are the Little Burro Mountains and Cerrillos. The turquoise from the best mines in these districts is famed for its excellence. In all four localities the turquoise deposits were once worked by the Aztecs or Indians and those near Cerrillos under Spanish rule.

LITTLE BURRO MOUNTAINS.

The turquoise deposits of the Little Burro Mountains, in Grant County, were described in this report for 1907. A brief visit was paid to the locality in July, 1909, to examine the recent work, the Azure mine being the only mine in operation. No new work had been done on the Parker mine and very little on the Porterfield mine. In the report for 1907 the distance by road from Silver City to the turquoise mines was given as about 15 miles; the new Silver City topographic sheet published by the Survey shows the Azure mine to be 10 miles S. 35° W. of Silver City. The mining camp is about 6,100 feet above sea level, and the Parker and the Porterfield mines are both about 6,000 feet above sea level.

The Aztecs or Indians operated some of the turquoise mines of the Little Burro Mountains as they did many other mines in the Southwest. The discovery of these deposits by white men dates back to 1885,[a] and although there is some dispute as to the original discoverers, the names of John E. Coleman, W. J. Foley, and Nicholas C. Rascome are prominent among those mentioned. The early work in this district was directed toward the remains of the Aztec mines with varying success. The Azure mine was discovered in virgin ground where there was no evidence of ancient mining.

Azure turquoise mine.—Mining operations at the Azure turquoise mine were begun in 1891 by the Azure Mining Company, of New York. The operations at this mine have been on a larger scale than at any other turquoise mine in the country, and the value of the production of turquoise is commonly stated to be from $2,000,000 to $4,000,000. The mine was worked by an open cut about 200 yards long, 100 to 200 feet wide, and over 60 feet deep in the deepest part, with adits on two levels below the openwork. There has been but little turquoise obtained from this old working during the last four years, though several shafts, crosscuts, and tunnels were driven in search of gem material.

During 1908 a new deposit of turquoise was opened about 150 yards east of the old mine by W. R. Wade, mining engineer of the Azure Mining Company. The mine is in the bottom and along the west side of a small draw. The deposit was once worked by the Aztecs, and their tunnels and openings filled with rubbish are exposed in the upper part of the mine. In the early days of turquoise mining in the Little Burro Mountains, M. W. Porterfield and associates prospected for the turquoise deposit near these old Aztec workings. The Porterfield tunnel missed the recently discovered deposit by a few feet only. The developments to the time of examination consisted of old openworks with tunnels, and recent shafts, drifts, winzes, raises, and stopes. There were two levels below the openwork. The first of these was the principal level and consisted of a tunnel about 260 feet long with three raises to the upper level, stopes, and a 50-foot inclined winze to the second level 30 feet lower. The tunnel was driven into the hill in a direction S. 25° W., nearly parallel with the course of the small valley. Mr. Wade stated that the development work amounted to nearly 1,200 feet. Mining operations are impeded during wet weather, as part of the openwork is in the bottom of the draw.

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[a] Zalinski, E. R., Turquoise in the Burro Mountains, New Mexico: Econ. Geology, vol 2, 1907. pp. 4[illegible]-492.

The country rock of the region around the turquoise mines is principally granite porphyry presenting different phases from nearly ordinary quartz porphyry to porphyritic granite. Some monzonite occurs. At the Copper King copper mine, one-half mile southwest of the New Azure mine, the rock is coarse porphyritic granite, composed of large pink orthoclase and white oligoclase crystals, gray quartz, and biotite mica. At the Porterfield mine, one-half mile to the southeast, the same type of rock occurs along with some dark-gray speckled monzonite. The rock around the Azure mine and to within a short distance of the more recently discovered deposit is medium-grained porphyry, occurring both as quartz porphyry and as granite porphyry. This rock has been partly altered and silicified by the deposition of quartz in many joint seams and fracture zones and in the interstices of the rock. The occurrence of a large number of seams of gray quartz cutting the rock at various angles is quite characteristic. The rock is gray to pinkish gray and is fairly hard. It is the formation in which the turquoise deposits of the old Azure mine occurred. The rock in which the new deposit has been found is a pinkish-gray granite porphyry with a rather fine ground mass inclosing large phenocrysts of gray quartz and smaller ones of feldspar. The feldspar in the rock near the turquoise deposit has been badly kaolinized. The rock may represent a slightly different phase of the regional granite porphyry or a separate intrusion. In places this rock is cut by only a few quartz seams, but along the fracture zones and near the turquoise veins quartz is more abundant.

The turquoise is found in a belt about 80 feet wide in a fractured zone of the last body of porphyry described. The porphyry has been broken by a series of roughly parallel joints with a strike of about N. 25° E. (magnetic) and a dip of 30°–60° E. and by fractures in other directions. The turquoise occurs in veinlets and seams along these joints. Mr. Wade states that there are six prominent seams in the belt and numerous smaller seams in the cross joints. The prominent turquoise seams and veins are readily followed and hold out for greater distances than those in the branching or cross veinlets, in which the turquoise extends only a few inches from the main veins in some places and to several feet in others. Some of the veins carry no turquoise for distances ranging from a few inches to several feet and may then pass into nearly solid turquoise veinlets or quartz and limonite stain with turquoise nuggets or patches. Some of the seams in which the turquoise fails are filled with a clay gouge-like material with or without iron oxide stains. In places seams of turquoise pass into nodular turquoise, the nodules lying loosely fitted together, being apparently the result of fractures in a once solid seam. These nodules range from small size to 3 or 4 inches in diameter. Those the size of a walnut are not rare. The seams and veinlets of turquoise range in thickness from a small fraction of an inch to over 2 inches, and the veins along the main joints are much thicker than this. They are not composed wholly of turquoise, however, and may contain considerable matrix and quartz. The turquoise seams occur both in hard silicified rock and in decomposed rock, with or without red hematite or brown limonite stains. Some of the seams are in gray porphyry without any associated minerals. The quality of the turquoise does not seem to vary greatly with the matrix unless decomposition has been extensive, when it may be discolored and altered. Representative specimens of discolored turquoise were kindly sent to the Survey by Mr. Wade for examination, and similar material was observed during the investigation of this mine and others in the region. Some of these specimens are composed of nodules of blue, bluish-green, and greenish turquoise with a core or shell of greenish-brown or brown turquoise; in other specimens the whole nodule is greenish-brown or brown. The same mottling and texture are common to the blue turquoise and to the brown. The green and brown colors are due to the presence of iron, as is shown by treating fragments of the mineral in boiling strong hydrochloric acid. In this operation the discoloration is removed, and pale-blue to nearly white, rather soft turquoise is left; the resulting solution contains iron, copper, phosphate, and probably aluminum. When pure green turquoise, both light and dark colored, is treated with acid, the green color is removed and pale-blue, soft turquoise is left. Hard, dark-blue turquoise is not so readily attacked, though the color is much weakened and some copper is taken into solution.

The color of the turquoise from the New Azure mine varies from dark-blue, sky blue, light or baby blue to nearly white, to blue with a greenish cast, to green, to greenish-brown, and to brown. Pure turquoise is obtained in pieces of size sufficient to yield large gems. The matrix presents considerable variation; in one type there is turquoise of two colors—often a light-blue with darker blue or greenish mottlings or round spots peppered through it, or there may be a gradation from one shade of blue to another or to green or brown; another type contains inclusions of quartz or wall rock, with or without iron stains, and seams and dendritic markings of brown and yellow stains. Veinlets of turquoise in the country rock, or turquoise fillings in brecciated zones with or without red or brown iron stains also produce attractive combinations.

The turquoise from the Azure mine holds an enviable position in the gem trade. The pure blue cut stones are marked with a circle on the back and are guaranteed to hold their color for many years. The matrix is not guaranteed and is not generally sold as the Azure product. The finest material from the old mine came from one large pocket and was called "Elizabeth" turquoise. The best turquoise from the new mine does not equal the "Elizabeth" variety in color or quality, though it is about equal to that from the other parts of the old mine. The yield from the new mine is satisfactory as regards quantity.

LITTLE HACHITA MOUNTAINS.

The turquoise claims in the Little Hachita Mountains, about 6 miles west of Hachita, in Grant County, have several owners. According to Sterling Burwell, an old resident of the Little Hachita Mountains, the first work done on the turquoise deposits of this region was by Con Ryan and himself between 1885 and 1888. This work was done for gold, as Con Ryan supposed that the ancient workings and dumps in the region were gold mines of the Aztecs or early Spaniards. Turquoise was found, and four claims for this mineral were then taken up by Harry Wood, who soon sold out to eastern purchasers. Archie Young then located all the ancient workings. Assessment work was kept up on a few of these claims only, and in June, 1908, George W. Robinson relocated four of the best claims, in which

M. W. Porterfield was given a half interest for financial assistance; these claims were operated during 1909, the first turquoise mining in the region for several years. Other claims are now owned by the American Turquoise Company, of New York, by M. M. Crocker, of Lordsburg, by the Mary Posey Mining Company, of San Antonio, Tex., and by R. S. Chamberlain.

For a few years from 1880 on there was a lively mining camp in this part of the Little Hachita Mountains, and a silver smelter was built about a mile east of the turquoise deposits. It is said that a little turquoise was found in some of the silver mines of this region. Turquoise is reported to have been worked several years ago by Nick Rascom at Silver Night, about 20 miles to the southwest of the present mines. This work was on old dumps, the remains of some of the old Aztec workings, which are numerous in the Little Hachita Mountains. Around one of these were a large number of stone hammers of crude workmanship. A thin section for microscope study from one of these hammers shows it to be an andesitic breccia or tuff. The hammer is greenish gray and is very tough; the material for it was probably obtained near the locality where it was used.

The Little Hachita Mountain turquoise deposits lie at elevations of 5,000 to 5,400 feet above sea level, or about 500 feet higher than Hachita. The claims are located in a semibasin country open on the east side of the mountains for about 3½ miles north and south and for 2½ miles to the east. The basin is surrounded by rock-capped hills from 600 to 1,000 feet higher on the north, west, and south than on the east, where low hills slope down to a large flat toward Hachita. The drainage is to the east in channels cut through these low hills. There are several small knobs, ridges, and spurs in the basin higher than the hills on the east. Prominent among these knobs is an elongated ridge nearly half a mile long in a northeast-southwest direction and slightly northwest of the center of the basin. This hill contains numerous turquoise deposits, especially at the northeast end, and is sometimes called Turquoise Mountain. In the description of the different turquoise prospects in the region locations will be given by distance and direction from the summit of this hill at its northeast end. The higher rim of the basin is a scarp with cliffs and steep slopes on the inner side.

The country rock of the region consists of a series of interbedded sedimentary, volcanic, and intrusive rocks. The sedimentary rocks are sandstone, slate, or phyllite, and limestone; and the volcanic rocks are rhyolite, trachyte, and andesite, which occur as breccias or tuffs, flows, sills, and dikes. The structure of the formations on the south and southwest rim of the basin is monoclinal, with a light dip westerly and away from the basin and a strike to the northwest. Whether this monoclinal structure continues up the west side of the basin to the north end was not determined. The southwest rim of the basin is composed of a heavy bed of gray cherty limestone. Below it are slates and beds of andesitic tuff, with trachyte near the base of the hill. Still lower in the series and in places in the bottom of the southern half of the basin are beds of volcanic tuff, rhyolite, limestone, slate, and greenish sandstone. A large area of the basin is occupied by trachyte, andesite, and probably monzonite, especially in the northern half. These rocks probably occur partly in the form of sills interbedded with the sedimentaries and other volcanic rocks, and partly as dikes or stocks. In the higher parts of the basin they remain uneroded, while in the lower parts the underlying rocks are exposed. The trachyte, andesite, and monzonite rocks are closely associated and both exhibit fine to medium-grained texture. Large areas of the trachyte are so decomposed that its original nature is uncertain. The turquoise deposits are associated with the altered trachyte and probably with altered andesite. In one of the mines a dike of altered porphyry, probably monzonite, was encountered. The low hills on the east of the basin are capped with cherty limestone, which may be the same formation as that on the west rim of the basin, dropped down by a great fault.

Robinson and Porterfield mines.—The claims owned by George W. Robinson and M. W. Porterfield are the Azure, along the top of Turquoise Mountain; the Cameo, nearly 1 mile north of west of the northeast end of Turquoise Mountain; the Galilee, three-fifths of a mile southwest of Turquoise Mountain; the Aztec, 1½ miles west of south of Turquoise Mountain.

There have been two sets of workings on the Azure claim, one at the northeast end of Turquoise Mountain and the other near the middle of the hill on the top. At the northeast end there were the remains of ancient Aztec workings, mostly filled in, and the prospects of the first white miners. Recent work consists of a tunnel about 160 feet long with a crosscut and stopes connecting with an open cut on the surface. The tunnel was driven in southwest from the northeast end of the hill, and near the end a crosscut was run to the southeast connecting with stopes to surface work above. This drift also encountered Aztec workings, mostly filled in with rubbish, and workings of later people, either Spaniards or early miners during the eighties. This latter excavation consisted of a drift about 35 feet below the surface with the old entrance completely filled with rubbish. This rubbish was either purposely filled in the exit by the early miners to conceal the deposit or has slipped in by the breaking down of the walls. The presence of a small rusted tin can in the bottom of the hidden tunnel and round drill holes suggests a later period of mining than that of the early Spaniards. The open cuts at the surface above were made by former miners and followed the Aztec workings.

The turquoise occurs near the contact of very fine-grained trachyte and a porphyry, probably monzonite, both badly decomposed. The contact of these two rocks extends northeast and is quite irregular. The turquoise is found mostly in the trachyte, especially where the latter has been fractured and stained with iron oxides. The rock has been badly broken and the turquoise fills the fractures with irregularly shaped seams ranging from a very small fraction of an inch to half an inch in thickness. These seams branch and cross one another and open abruptly out from small size to large size. Where the rock is very badly fractured the joints are sometimes all filled with turquoise forming masses of matrix of good size. The matrix is harder where strongly stained with yellow and brown iron oxide, and in combination with the fine color of part of the turquoise it makes beautiful matrix gems. The turquoise ranges in color from dark sky-blue to pale blue and greenish blue. The dark blue and the greenish blue are very hard; the pale blue variety is rather soft. The principal yield from this claim is in matrix turquoise with some good cameo material.

At the southwest end of the Azure claim two open cuts were made in a northwest direction. These cuts were in trachyte rock and exposed seams of turquoise having a northeast strike. Other veinlets of turquoise outcrop along the ridge near by, associated with limonite stains. Some very hard turquoise with a fine pure blue color was found in the seams in heavily iron-stained rock.

On the Cameo claim a shaft has been dug 40 feet deep and drifts with stopes run from it in a northeast-southwest direction. These drifts and stopes were made on a prominent veinlet of turquoise which strikes northeast with a vertical dip at the surface and inclines at about 75° NW. from a depth of 20 feet to the bottom. The inclosing rock is a yellowish-gray altered trachyte. On the hill above is a massive outcrop of hard, dark andesite. In the bottom of the shaft the best turquoise has been found in a band of rock 7 feet wide lying between two prominent joints or veinlets with a northeast strike and a high northwest dip. Other seams of turquoise occur in varying positions, some lying nearly horizontal and others striking northwest. It is said the best turquoise has been found at points where some of these side seams cross the main veinlets. The turquoise occurs principally in veinlets and seams, the largest half an inch thick. These veinlets are hard and firmly attached to the wall rock, which is sufficiently hard to serve as a matrix, and some of the turquoise is cut into cameos with it as a base. The wall rock of the seams is yellowish-gray to brownish in color. The best turquoise has a good pure blue color, locally passing to greenish-blue. This deposit was originally worked by the Aztecs and remains of their work with their stone hammers are still to be seen near the present openings.

The work on the Galilee claim consists of a large shaft or a small irregularly-shaped pit about 20 feet deep. The rock formation is altered trachyte of fine grain and strongly stained with iron oxides. The turquoise occurs in two main veinlets or seams and in a few smaller less pronounced ones. The veinlets are fracture zones strongly stained with limonite, having turquoise in spots or in small rounded grains distributed throughout.

The Aztec claim is on the northeast slope of the southwest side of the basin about 500 feet below the rim. There were Aztec workings on this deposit, and a tunnel was run under them by Harry Wood. Some stoping was done in this tunnel. Mr. Robinson has made a new opening above Harry Wood's tunnel and to the south of the Aztec workings. The deposit is in decomposed trachyte in part stained and hardened by iron oxides and in part still light-colored and soft. On the hill above the mine there is a ledge of heavily pyritized trachyte. The turquoise is found in seams filling pronounced joints and generally associated with limonite stains, and in balls or nuggets in leads through the trachyte or isolated. The nuggets are said to yield better turquoise than the veinlets. Streaks of gypsum occur in the trachyte near the turquoise leads. The turquoise from the Aztec claim is not of so good grade as that from some of the other claims. Much of it is rather soft and pale. Some of the turquoise with good color when fresh fades somewhat on exposure.

American Turquoise Company mine.—The American Turquoise Company mine is a little over 1 mile north of west of Turquoise Mountain and a few hundred yards west of the Cameo claim. This mine was opened by a shaft 60 feet deep with a drift and raise to an open cut, and by another open cut about 150 yards to the north. The country rock is fine-grained light-gray to grayish-yellow stained altered trachyte. Specimens obtained from the dump contained inclusions of darker rock also altered. These inclusions may be from the lower part of the trachyte sill where fragments of the underlying andesite were caught up. The workings are in a direction of N. 10° E. and evidently followed a pronounced vein or set of veins, the dip of which is about vertical. The turquoise has been deposited in a fracture zone in veinlets and seams. It is said only pure turquoise was obtained from this deposit and that there was little material for cutting into matrix. The best turquoise has a good blue color and is quite hard.

M. M. Crocker claims.—The M. M. Crocker turquoise claims are the Azure No. 2 on the southwest end of Turquoise Mountain, and the Twilight, on a small knob one-half mile south of west of Turquoise Mountain. The work on the Azure No. 2 claim consists of a shaft 40 feet deep and an open cut at one place and an 8-foot pit a few hundred yards to the southwest. The 40-foot shaft was sunk in decomposed trachyte with andesite near by on the east. A strong seam of turquoise running about N. 25° E. and vertical was encountered. In the pit several smaller seams of turquoise with about the same dip and strike were found in altered trachyte.

The Twilight claim was opened by Mr. Robinson for Doctor Crocker by two pits. The country rock is trachyte and contains a few small seams of turquoise. Much of the turquoise is greenish blue, and the seams are bordered with heavy stains or films of limonite.

R. S. Chamberlain mine.—The Calmea claim of R. S. Chamberlain is on the east side of the northeast end of Turquoise Mountain. The deposit was marked by large Aztec workings, and has been tested by pits by several prospectors. A 40-foot shaft sunk by Mr. Chamberlain with a drift to the east is reported to have encountered ancient workings to that depth and so extensive as to make further mining difficult. The deposit appears to be along the contact of trachyte and monzonite or andesite. Little was seen of the formation or of the quality of the turquoise found.

Mary Posey Mining Company mine.—The mine of the Mary Posy Mining Company is about one-third of a mile north of Turquoise Mountain. A shaft was sunk at this point for silver. Turquoise was reported as found in this shaft.

Another claim, called the Le Feve claim and owned by parties in Clifton, Ariz., has been opened across a draw a little over half a mile S. 20° W. of Turquoise Mountain. A little turquoise was found here in soft decomposed trachyte.

VARISCITE.

The use of variscite in jewelry has increased greatly during the last two years and has created a considerable demand for good gem material. The growth of popularity of this gem is due to the appearance on the market of matrix material exhibiting a large variety of pleasing colors with innumerable combinations of patterns or markings. The two deposits of variscite first mined for gems in Utah were described in this report for 1908; namely, the utahlite or chlorutahlite mine of Don Maguire, of Ogden, and the amatrice mine of the Occidental Gem Corporation, of Salt Lake City. The occurrence of a variscite mine in southwest Utah, owned by John A. Maynes, of Salt Lake City, and a new discovery in Esmeralda County, Nev., were also mentioned. The latter locality has been taken up by the Los Angeles Gem Company and was examined in August, 1909. A description is given below of the deposits owned by this company. Since the operations of the Los Angeles Gem Company were started deposits of variscite have been located at several other localities in Nevada, and at one other in Utah. A number of these were examined in May, 1910, and will be described in the report for that year. The properties in Nevada are those of G. E. Wilson, Abner Capps, Carl Rick, and W. K. Botts, a few miles to the north of Coaldale; of Clyde Carr and Mrs. Mattie Lovejoy, 10 miles north of Blair Junction; of Mrs. Clara Dunwoody, C. M. Dunwoody, and C. Prichard, 8 miles southwest of Sodaville. The variscite deposit near Candelaria which has been known for a number of years was also examined. The title to this deposit is under dispute. At the time of examination the name of George W. Brown, a Cherokee Indian, was posted on the location monument, though it was reported that the property had not been given up by E. J. Tilden, of Goldfield, a former owner. In Utah a new deposit of variscite of bright green color and in large masses was located by Frank Edison and Edward Bird, 5 miles northwest of Lucin. A description of this deposit also will be given in the report for 1910.

NEVADA.

The variscite deposits of the Los Angeles Gem Company are in two groups. One of these is about 2 miles west of Rock Hill siding of the Tonapah and Goldfield Railroad, between the stations of Redlich and Coaldale. The other and larger group is about 1½ miles northwest of the deserted mining camp of Columbus. Columbus is about 5 miles southwest of Rock Hill, on the west side of the Columbus borax salt marsh. The two variscite localities are about 2 miles apart in a northeast-southwest direction. They are in the foothills on the east side of the Candelaria Mountains at elevations ranging from 4,700 to 5,200 feet above sea level, the elevation of Columbus being 4,625 feet. In the notes given below magnetic readings are used, the variation being nearly 18° east of true north. The line of hills in which the deposits occur have a north of east trend, with the main drainage lines crossing them in a southeasterly direction. The hills are in part very rough and rocky with smooth surfaces in places, in a measure due to outcrop of softer rocks. The mining camp of Columbus is on a large alluvial cone, sloping gently to the salt marsh on the east and at the mouth of one of the larger valleys from the mountains on the west. Thirty years ago there was a population of several thousand people at Columbus; at present it is occupied by a few gem miners or occasional prospectors only. Of the numerous well-constructed adobe houses once standing in Columbus there are still some ten or a dozen in fairly good condition, although the majority have slowly fallen to pieces after the woodwork was removed for fuel or buildings in adjoining camps by prospectors. The ruins in the dry desert region, with its scant vegetation of scattered sage-brush bushes, its white salt marsh, and the snow-capped White Mountains of California in the distance, are most picturesque. A supply of good water, though somewhat sweetish from the presence of borax, is obtained at a shallow depth from the wells of the deserted town, and is used by prospectors for miles around.

The variscite deposits were discovered by L. A. Dees, of Los Angeles, Cal., and Edward Murphy, of Esmeralda County, Nev., early in the spring of 1908. The discovery of new deposits was made at intervals until some half a dozen claims had been located. These claims were later sold to the Los Angeles Gem Company. While the claims were being operated Mr. Dees discovered a new deposit near by, and this was also taken over by the Los Angeles Gem Company. The deposits were operated for a short time by Messrs. Dees and Murphy, and later by John Caswell, a turquoise miner from Mineral Park, Ariz.

The variscite claims owned by the Los Angeles Gem Company are the Turquoise Butte or Robin's Egg, the Brownie No. 2, the Pirate, the Pirate No. 2, the Pirate No. 3, the Pirate Fraction, and the Emerald. The Turquoise Butte or Robin's Egg, as it is sometimes called, covers the variscite deposits to the northeast of the larger group of deposits. The Brownie No. 2 claim is about 1 mile northwest of Columbus and half a mile southeast of the main line of variscite deposits. The other claims include a number of variscite deposits in a belt 1 mile long in a north of east and south of west direction, and a few hundred yards wide. In order of occurrence from east to west these claims are—the Emerald, the Pirate Fraction, the Pirate, the Pirate No. 2, and the Pirate No. 3.

The development work necessary to secure a quantity of variscite has not been large, and at the time of the first examination there were no openings over 10 feet deep. Most of the work was in the nature of prospecting and location and consisted of pits and trenches, the largest 8 feet deep, 10 feet wide, and 25 feet long. The mining of variscite does not require extensive equipment or work, but the hardships attending the life in the desert in a large measure offset these advantages.

The rock formations of the variscite region consist principally of massive siliceous or cherty limestone and slate, rhyolite tuff, and slaty rhyolite, and sandstones or sandy shales and shales. Small bodies of altered trachyte occur near some of the deposits, and a little biotite granite porphyry was observed to the south of the gem claims. The formations encountered in a traverse from Columbus to the northwest are a large belt of limestone with some associated rhyolite, rhyolite tuff with slaty rhyolite, and sandstones and shales. The limestone is dark-gray to nearly black and contains many cherty and siliceous phases which may be called jasperoid. The rhyolite tuff is dark gray and presents coarse phases resembling conglomerate with angular fractured pebbles. The slaty rhyolite is a hard light to dark gray rock, and often exhibits flow banding; it is dense-grained to cherty in appearance and is sometimes difficult to distinguish from siliceous phases of the limestone and slate. The sandstones and shales outcrop in the higher hills to the north of the deposits where they probably overlie the continuation of formations just described. These sandstones and shales are gray to buff and red.

The trend of the formations varies from east and west to northeast and the dip is principally to the north and northwest, along the main line of deposits. Local variations of both dip and strike occur. There has been considerable faulting in the region, and some of the hills are evidently formed by block faults with the fault planes forming scarps facing east and southeast. Besides these larger faults the formations have been badly fractured and brecciated with a subsequent mineralization by silica and other minerals in the fissures. Silicification along these fractures has resulted in hardened rock which outcrops as prominent ledges. The outcrop of the limestone is generally very rough, especially along siliceous or cherty ledges. Much of the rhyolite forms rather smooth appearing hills whose surfaces are covered with sharp angular and shell-like fragments of rock that are exceedingly hard on shoe leather. Ledges of silicified, slaty rhyolite and tuff form very rough outcrops on the hilltops and slopes.

The variscite deposits occur in the limestone, rhyolite, and sandy shale formations, and some are associated with small trachyte dikes. The variscite occurs as a filling in fissures and joints replacing other minerals, and as segregations in the altered rocks. In the fissures the variscite not only fills the seams and joints but the crevices between shattered and brecciated fragments of rocks along the fissures. Thus brecciated zones several inches thick may have several main veinlets of variscite with numerous small seams and irregular patches of variscite between them. Some of the larger veinlets can be traced for many feet; the smaller ones are less persistent and vary in direction. The different deposits seem to bear little relation to one another and no definite veins of variscite are found through a distance of many yards. The individual seams and veinlets of variscite vary from paper thickness to 2 to 3 inches in width. The variscite-bearing streaks and breccia zones may attain a thickness of over 2 feet. The replacement and segregation deposits are nodular growths of variscite and allied phosphate minerals in more or less altered and porous rock. There is a tendency to nodular segregations along many of the veinlets, and some of the latter pass into nodular variscite lumps scattered through the rock. The more prominent veinlets of variscite generally occur in joints or fissures with a northeast trend and a vertical to high northwest dip. In some of the prospects the deposits are quite local and can not be traced more than a few feet in any one direction.

A feature common to the occurrence of variscite in the different localities is the tendency toward lenticular and nodular segregations, both of the variscite and of other minerals associated with it. Of the associated minerals there are allied phosphates, some of which may be variscite of different color from that ordinarily found. It would take a quantitative chemical analysis to determine the nature of each of these, and there might then be found a series of phosphate minerals with gradations from one to the other, still only determinable by chemical analysis.

The Turquoise Butte or Robin's Egg claim is located across a small rocky knob or summit at the end of a southward-extending ridge. There are several seams and veinlets of variscite outcropping within a distance of 75 feet of the main deposit. At the latter place there is a larger vein, ranging from a fraction of an inch to 3 inches in thickness, that has split into two smaller veinlets. The veinlets have a variable strike of N. 30° to 50° E. and a high northwest to vertical dip, cutting across the inclosing rocks at a small angle. The deposits are in dense chert-like rhyolite. A few hundred feet to the north is a wide area of buff-colored shales, and to the south hard siliceous limestone or jasperoid. The seams of variscite are irregular in thickness and continuity and in places are composed of nodular lumps and disconnected lenses of variscite with a chalky filling between them. In places, where the veins are widest, they contain more or less brecciated wall rock inclusions in the variscite. These inclusions may be ordinary dark-gray rhyolite or more or less brown iron-stained fragments. The color of the variscite from this deposit ranges from pale green to fairly dark green. Pure green stones can be cut weighing 25 carats or more, and much larger mottled and matrix specimens can be obtained. The Robin's Egg claim has been a good producer and has been worked to a depth of 20 feet during 1910.

The Brownie No. 2 claim is in a low-lying bed of siliceous limestone or jasperoid in the bottom of a wash only a short distance above the upper edge of the cone of drift material extending down to Columbus. The variscite occurs in seams, veinlets, and nodules irregularly distributed through the inclosing rock, which has been badly brecciated and lime and iron oxides have later been deposited in the fractures. The variscite ranges in color from nearly white to pale green and yellowish green. The massive portions of the veins are marked with fine irregular mottlings in places, and some of the variscite incloses irregular fragments of the wall rock.

The Emerald claim has proved an especially good one in both quality and quantity of output. A share in this claim has been purchased by the Verde Gem Company, of Los Angeles, and the two companies operate the claim together. Only a small pit in a low nearly flat ridge had been made at the time of examination in 1909. A hasty visit was made in 1910 to this claim, at which time there was an 18-foot shaft and a pit 20 feet long, 10 feet wide, and 8 feet deep. The country rock around the deposits is hard chert-like rhyolite, which strikes east and west with a dip of 25° N. The variscite occurs in veinlets cutting across the rhyolite with a northeast trend and a nearly vertical dip, and in nodules and ball-like segregations. The veinlets pinch out or are replaced by nodular and lenticular segregations of variscite. The balls and nodules range up to 2 inches in diameter and the seams or veinlets to over an inch in thickness. These masses are composed of dark-green variscite, inclosed in a black matrix. The variscite is in rounded lumps and irregularly shaped patches completely enveloped in veins and balls of black matrix. The black matrix may be black variscite, for t contains alumina, phosphoric acid, water, and a little iron; the texture also somewhat resembles that of variscite. Some of the nodules are composed of black variscite or phosphate alone with no green parts. Others are principally black with shotlike mottlings of dark grayish-green variscite, scarcely visible in the black. The variscite nodules are reported to be scarce in the lower parts of the openings, though the veins hold out well and exhibit the same patterns as found in the variscite. The nodules found near the surface are probably weathered fragments of segregations in the veinlets.

Outcroppings of other veinlets and nodules of variscite have been found on the Emerald claim. At one place pure white nodules 2 to 3 inches across were found. This material may be white variscite or an allied phosphate mineral, as it contains some of the same elements as variscite. At another point variscite or an allied mineral, pale-green to white in color, occurs closely associated with an altered trachyte dike. This trachyte is crowded full with pisolitic balls and small nodules of the variscite-like mineral and is further stained with yellow phosphate films in the seams.

On the Pirate Fraction claim a very similar occurrence of pisolitic variscite or phosphate mineral has been found in an altered trachyte dike 6 inches to 2 feet thick. The rhyolite adjacent to the trachyte has also been decomposed and has innumerable oolitic and pisolitic segregations of dark grayish-green phosphate scattered through it. These oolites have a radiated spherulitic structure and between crossed nicols under the microscope are seen to be true spherulites with a negative character and a fairly high birefringence. Between the two occurrences of pisolitic variscite or phosphate is an outcrop of sandy gray rock, that may be shaly sandstone or altered rhyolite, in which are many augenlike concretions of a yellowish mineral. These augen or lenses range up to an inch in thickness and are composed of yellowish phosphatic mineral.

On the Pirate claim variscite has been found at four different places in different modes of occurrence. The principal rock with which the variscite is associated on this claim is rhyolite, in places hard and chertlike and in others decomposed and soft. This rhyolite strikes about east and west with a 20° to 30° dip to the north. A trachyte dike about 1 foot thick cuts across the formations. The deposits are along the top of a ridge and in the low draw on the north. In two openings near the top of the ridge the variscite is found as shells coating balls of soft gray decomposed rhyolite, and also in patches through these balls. The latter range in thickness up to 2 inches and in some cases have no variscite associated with them. The variscite associated with these decomposed rhyolite segregations has a good green color, but there is little of it in sufficiently large pieces for cutting and the matrix is too soft to cut with it. In an open cut near by a pale-green variscite in many small nodules composing larger ones presents a cobweb or turtle-back effect. A few very thin seams of variscite were found in the less altered rhyolite in these cuts. Fifty yards farther north, down the hill, a stringer of variscite, three-fourths of an inch thick in places, was found cutting across the country rock with a northeast strike and a 50° dip to the northwest. The best variscite on this claim was found in two prospects, about 100 feet and 400 feet, respectively, east of the last-mentioned opening. In the first prospect dark-green variscite with black mottling occurs in one main veinlet, with irregular branch seams. In the other opening deep-green variscite occurs in a vein inclosing a dark-gray and black breccia matrix.

The Pirate No. 2 claim is farther west along the ridge in which the Pirate claim is located. The backbone of this ridge is composed of a ledge of hard silicified rhyolite tuff and breccia resembling a fractured conglomerate. The ledge strikes north of east and the same formation forms small knobs along this line for nearly a mile to the west. The variscite deposits are near the west end of the ridge on the south side of the tuff-breccia ledge. Five small cuts were made exposing one prominent veinlet of variscite, nodular variscite, and several small seams. Some of the variscite in the main vein has a nodular form with a chalky filling between the nodules. The latter are built up of numerous smaller lumps or balls with a brownish filling between them. These give cobweb or turtle-back effects when cut. Considerable pale-green solid variscite is also found.

On the Pirate No. 3 claim little if any variscite has been found. The veinlet prospected is turquoise and has been described under that mineral. The turquoise veinlets have a greenish color in places like that of variscite. When tested by the flame coloration test copper was found present even in the greenest material, so that it can not be variscite, but is more nearly turquoise.

The numerous variations in shades of color and in manner of occurrence of the variscite in the different deposits furnish material for a large variety of cut gems. The variscite ranges in color from greenish-black to deep emerald green, bluish-green, yellowish-green, light green, and pale green grading into white. Some of it is mottled with two or more of these colors. The matrix ranges from black to dark and light brown, yellowish, dark and light gray, and white. More than one of these colors or shades of color often occur together. Varieties of patterns are produced principally by the matrix in the variscite, though some of the mottled variscite of more than one color gives pretty effects. The markings due to the matrix vary with the conditions under which the variscite is formed. Where a brecciated zone was filled in with variscite the gem material may show inclusions of angular fragments of varying size of dark or light gray rhyolite, with or without brown or yellow iron stains. In other specimens the matrix predominates and the variscite occurs in one or more veinlets cutting through it. Some of the finest gems are obtained from matrix deposited with the variscite in the veins and nodules or in later fractures formed in them. The matrix may consist of cherty silica, phosphates allied to variscite, iron oxides, and other materials. These may occupy large portions of the gem material or may fill thin fractures or branching seams. The effects obtained by cutting such matrix are varied and beautiful. The nodules and veins of black phosphatic mineral with inclusions of deep green variscite patches from the emerald claim is probably the finest matrix cut by the company. The dark-green stones with delicate seams of black, sometimes with nearly dendritic structure, are also very beautiful, and much the same may be said of similar stones with brown markings. Lighter shades of green to nearly white with good markings, as in the turtle-back material from the Pirate and the Pirate No. 2 claims, are much admired. The pale-green and the yellowish-green variscite with the delicate markings, as found in the Brownie No. 2 claim, finds many admirers.

MISCELLANEOUS GEMS.

UNITED STATES.

SATELITE.

California.—The new gem "satelite," placed on the market by the Southwest Turquoise Company early in 1908, has been very well received in the Southwest. The cabochon-cut stones give an excellent cats'-eye effect and the dull green color is pleasing. Satelite is serpentine pseudomorphous after amphibole, probably the tremolite variety. The rough mineral looks very much like low-grade asbestos, though the fiber is not so fine. It is a magnesium silicate containing water, which distinguishes it from amphibole. The refractive index is much lower than that of tremolite or about that for serpentine.

Satelite is obtained from the south end of Venice Hill, 8 miles east of Visalia, Tulare County, Cal. This locality has been partly described under chrysoprase. The deposit was discovered in 1897 by Jerome Prethero while prospecting for asbestos. The possible value of this serpentine as a gem was not considered for ten years after the deposit was discovered. Only a small amount of work was necessary to secure satelite sufficient to supply the early demands of the company. When visited in August, 1909, the work consisted of a pit about 15 feet long and 4 feet deep with a northeast trend. The rock around the deposit is complex and consists of both serpentine and soapstone. The country rock at the south end of Venice Hill is serpentine, with beds of chloritic schist and talcose soapstone. The vein carrying the satelite is lenticular, pinching down to an inch or two in thickness near the ends of the cut and swelling to nearly a foot thick at the middle. The satelite does not occur in compact pure masses, but in lenticular and flat sheets with weather stains around them, or with one portion nearly pure satelite serpentine and the adjoining part silicified and hardened by chalcedony. About 150 yards south of west of the satelite deposit a vein of dull green chalcedony 6 inches thick has been found in a serpentine outcrop. This material shows small concentric agate-like growths with radiated crystalline centers through greenish chalcedony resembling prase. A small amount of strongly silicified satelite was found with this. It is possible that this greenish chalcedony would cut into attractive forms. Satelite is retailed at 50 cents per carat for the poorer grades and at $1 or more per carat for the best grades.

APRICOTINE, CREOLINE, VERDOLITE.

Three varieties of miscellaneous gems have recently been introduced by Louis J. Deacon, of Atlantic City, N. J. These stones are used principally for the tourist trade and would be very useful for the arts and crafts work. They have been called "apricotine," "creoline," and "verdolite." Mr. Deacon kindly loaned samples of the cabochon-cut stones for examination and furnished rough specimens of each, along with notes on their occurrence.

Apricotine is cut from flattened waterworn quartz pebbles, which have delicate reddish and yellowish-red tints of color resembling those of a ripe apricot. These pebbles are found about 2½ miles above Cape May, on the New Jersey shore of Delaware Bay, on a portion of beach generally covered by water. When the tide is very low a few pebbles suitable for cutting may be found after diligent search. The clear quartz pebbles called "Cape May diamonds" are found at the same locality. The majority of the pebbles have a poor color or are badly checked and flawed. The pebbles are composed of angular, close fitting, interlocking grains of quartz, which show some strain between crossed nicols under the microscope. The color pigment consists of very small amounts of iron oxide dust in some of the small cracks and interstices. Apricotine polishes well and the delicate colors combined with the translucency furnish an attractive and unique gem.

Creoline is an epidotized altered trap rock found in a ledge in the Brighton district of Boston, Mass., near the Roxbury "puddingstone" formation. The ledge is a mineralized fracture zone, in which the creoline occurs in pockets. A specimen examined under the microscope was composed of epidote grains with a pale to strong lemon yellow pleochroism, altered plagioclase, secondary quartz, probably some zeolite, pale-greenish actinolite needles and sheafs of fibers, and hematite dust or tiny grains. Calcite occurs in seams. Specimens of creoline exhibit a purplish-gray or brown-colored matrix with dark red spots inclosing yellowish-green epidote in spots and streaks with or without gray or white quartz and calcite. Mr. Deacon named the stone from the resemblance the colors bear to those of creole marble. Creoline receives a good polish, which displays its colors very prettily.

Verdolite is obtained from a vein in a quarry for building stone and road metal on the New Jersey side of Delaware River, near Phillipsburg. It is composed of rose-pink to white dolomite in granular and crystallized masses along with green talc in scales and fibrous masses. The latter occur in seams and patches in the dolomite. The translucent green talc in delicately rose-tinted and white dolomite make beautiful contrasts. The stone is too soft to receive a high polish and the talc generally wears out deeper than the dolomite in cutting. The name verdolite [a] was given by Wm. B. Reed, of Easton, Pa., to an ornamental stone quarried in that region. The material cut for gem purposes is very similar to the ornamental stone.

WABANITE.

Mr. Shelly W. Denton, of Wellesley, Mass., mentions the use of a purplish chocolate-colored rock with cream-colored mottlings in the arts and crafts jewelry. This material was found by Mr. Denton in the vicinity of Wellesley and has been called "wabanite," after a former noted Indian of that region. The quantity of wabanite obtained was limited. Specimens of the rough gem and a cut stone furnished for examination consisted of very fine-grained siliceous slate, which may have once been a rhyolite or similar volcanic rock. It is roughly banded with black and gray layers, which are in places much contorted and crinkled.

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[a] Talc deposits of Phillipsburg, N. J., and Easton, Pa.: Ann. Rept. Geol. Survey New Jersey, 1904, pp. 172–173.

DOVE-COLORED CHERT.

Mr. William Kley, of Denver, Colo., very kindly sent in to the Survey a specimen of a new stone being cut for gem purposes. This material was found in New Mexico by F. H. Stanwood, of Colorado Springs. It is composed of dove-colored chert breccia, with a filling of lighter gray-colored fragments and cement. The stone polishes well, especially the larger fragments of dove-colored mineral, of which it is chiefly composed. As a scarf pin or similar jewelry this stone should look well; its charm lies in its simple color.

REALGAR.

Prof. C. G. Wheeler, of Chicago, reports the use of small quantities of realgar, arsenic sulphide, for jewelry. The material used comes from near Mineral, Lewis County, Wash., and is handled by the Mineral Creek Mining and Smelting Company, with offices at 300 Wabash Avenue, Chicago.

COLORED PORPHYRY.

Mr. A. L. Delkin, of Seattle, Wash., has kindly furnished samples of fine-grained quartz porphyry with bluish-green, greenish, and brown colorings from the River Range, Mohave County, Ariz. In some of the specimens the bluish-green and brown colors occur together in pretty contrast. This porphyry is fairly hard and receives a good polish. Some of it has been cut with attractive results. The porphyry contains small phenocrysts of glassy quartz. It probably represents a partly altered rock which has been hardened by silicification and colored by a small amount of pigment. A little white opal, occurring as float in the same region, has also been cut.

JASPER COPPER ORE.

The possibility of a new copper-ore gem or ornamental stone from the Humming Bird Mine, in Paris Canyon, near Montpelier, Idaho, has been suggested by H. S. Gale, of the United States Geological Survey. The specimen examined was obtained from the dump at the mine by Mr. Gale. The constituent minerals are quartz, with a very fine red dust pigment and malachite. Under the microscope the quartz is seen to be granular, with close fitting grains and is dusted full with minute red specks, probably hematite. The malachite is in bright green grains and masses with a radial fibrous and occasional spherulitic crystallization. The quartz incloses numerous small grains or buhrs of malachite bristling with needles. In the hand specimen the rock is bright jaspery red, with dark-green splotches throughout. The quartz is close-grained and tough, and takes a good polish. The malachite is softer, though sufficiently hard to be polished along with the quartz. The contrast between the two colors is pleasing and for use in small ornaments, as inkstands, paper weights, etc., the rock would serve well. It is also probable that it would be accepted as a gem for scarf pins, brooches, etc.

The specimen examined measured only a little over 2 inches square, and was associated with white quartz. It is not known from what part of the mine this material came, nor whether a plentiful supply could be obtained.

VARIOUS COPPER ORE GEMS.

Among the miscellaneous copper-ore gems may be placed the copper-stained silver ores from the desert regions of Nevada. These ores may be quartz or porphyry ores containing some or all of the following minerals: Blue azurite, green malachite, and bluish-green chryscolla stains in seams and fractures. In some cases ruby silver or other silver minerals are present, and hematite and other iron ores also occur. There are numerous localities where such material can be obtained. Good specimens have been seen from the mine of G. E. Wilson, 2 miles northwest of the deserted mining camp of Columbus, and from a mine owned by R. J. Jones, between Candelaria and the White Mountains in California.

MEXICO.

CARMAZUL AND CHRYSOCARMEN.

Of the oxidized copper ores recently used in jewelry is a variety from Lower California, Mexico, showing dark red and brown colors mottled with light and dark blue and small amounts of green. The variations in patterns, colors, and shades of colors are large, and along with the fair polish that the material receives, render it a pretty ornamental stone or gem. This copper-ore gem was named "Carmazul" by Oscar Wehrend, of Los Angeles, and is handled by the Whitley Jewelry Company, of Los Angeles, under that name. A material of very similar nature, both in coloring and composition, also obtained from Lower California, has been sold by E. Schaaf-Regelman in New York under the name of "Chrysocarmen."

Carmazul and chrysocarmen are composed of hematite, jasper, chalcedony, and quartz, through which chrysocolla and small amounts of fibrous malachite occur in masses, veinlets, and patches. The hematite and jasper appear to have been the original minerals and after fracturing were filled with the bright-colored copper ores.

CALAMINE.

The beautiful blue, gray, and green calamine obtained by Charles H. Beers, of the Ysabelita Mining Company, in Mexico, and described in this report for 1908 has been called "Chalchihuitl." This name has been chosen by Mr. Beers, since it is thought that the mineral answers the description of the mineral by that name so much esteemed by the Aztecs. Mr. Beers[a] states that this name has been pronounced acceptable by several mineralogists and experts on precious stones, as Max Bauer, Alfred Free, and C. N. Warren. Alfred Eppler,[b] of Crefeld, says this stone has been described by Bernal Diaz as the original chalchihuitl of the Aztecs. According to this description

[a] Personal letter.
[b] Jewelers' Circ. Weekly, July 20, 1910, from Deutsche Goldschmiede Zeitung.

the mine worker in whose possession the first piece was found claimed to be a descendant of Montezuma and stated that the mineral was chalchihuitl. The name chalchihuitl has not been definitely given to any other modern gem, though George F. Kunz[a] has shown that several green minerals were thus called by some early writers. Among these minerals were turquoise, green quartz or prase, and jadeite. Doctor Kunz favors turquoise and jadeite as the two probable varieties of chalchihuitl of the Aztecs. The difficulty of placing this name on the proper mineral has probably arisen from the fact that greenish minerals were very pleasing to the Aztecs, who therefore used several varieties, calling each chalchihuitl. Whether calamine of gem quality is the chalchihuitl of the ancient Aztecs may never be proved, but, coming from Mexico, the home of the Aztecs, the name seems fairly well chosen.

Calamine is hydrous silicate of zinc found with other zinc minerals in the zone of oxidized ores. It commonly occurs in groups of crystals, stalactitic, mammillary, and botryoidal masses with a fibrous structure and drusy crystal surfaces. The mineral is heavy, the specific gravity ranging from 3.4 to 3.5. The hardness is about 4.5 to 5, so that the cut gems should not be treated roughly, lest they lose their polish. Calamine occurs in transparent to translucent masses ranging in color from colorless to white, gray, bluish, greenish, and sometimes yellowish. The variety called chalchihuitl ranges from delicate bluish to gray to greenish in color. Part of it has fibrous silky texture with radial structure. Often there is a delicate curved banding across the direction of the fibers. As mentioned by Mr. Beers, these markings give the effect of the rays of the rising sun. Chalchihuitl is translucent, and some specimens have an even texture and color, either blue or green. The latter stones resemble chrysoprase and the green smithsonite from Kelly, N. Mex. The stones are cut principally "en cabochon," and may be used in a variety of jewelry.

Mr. Beers believes he has found the mine from which the chalchihuitl was obtained in an "antiqua" or ancient working some 300 feet across and nearly 150 feet deep. It is hoped further search will reveal more gem material, especially of the bluish variety, as the supply of that is becoming scarce. During 1909 several thousand dollars worth of chalchihuitl gems were sold.

CINNABAR QUARTZ MATRIX.

According to Mr. A. L. Shelby, of the George Bell Company, of Denver, that company has been cutting a matrix stone composed of bright red cinnabar in milky quartz. This material is sufficiently hard to polish well and is very suitable for cuff buttons, pins, etc. Only a small quantity was obtained from Mexico, the exact locality not being learned.

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[a] Gems and precious stones of Mexico: Trans. Am. Inst. Min. Eng., vol. 32, 1902, pp. 55–93.

PRODUCTION.

There was a large increase in the value of the output of precious stones in the United States during 1909. Among the gems showing large increases are turquoise, variscite, tourmaline, and chrysoprase. These minerals, along with sapphire, californite, and kunzite are credited with large values in the table of production. Of the above gems all but sapphire showed an increase in value in 1909 over 1908. A number of precious stones, as beryl, garnet, peridot, and topaz, showed a large decrease in value. Many changes, both increases and decreases, are recorded among the minor and other gems.

As in former years it has been necessary to estimate the value of some of the minerals from the quantity of the production reported. In doing this it is the aim of the Survey to give the value of the rough material rather than that of the elaborated gem. It is not always possible to give values for the rough gem material, since the output reported is in many cases the quantity and value of selected material or manufactured products. Some producers fail to report their output of precious stones to the Survey. In other cases gem material is mined or purchased by persons not regularly in the trade and whose names are not on the Survey lists, so that no record is obtained of their production. Under such circumstances it will be understood that the table given below is not to be considered an accurate statement of the production of precious stones. It is rather an approximation from which a general idea of the status of the precious stones industry in the United States can be formed.

The statistics of production of precious stones in 1909 were collected in cooperation by the United States Geological Survey and the Bureau of the Census.

Production of precious stones in the United States in 1906, 1907, 1908, and 1909.

	Value.				Remarks.
	1906	1907	1908	1909	
Agates, chalcedony, etc., moonstones, etc., onyx.	$800	$650	$1,125	$750	About 1,000 pounds; California, Colorado, and Washington.
Amethyst	700	850	210	190	North Carolina, New Jersey, Colorado, and California.
Azurmalachite, malachite, etc.		250	5,450	2,000	Southwestern States.
Benitoite		1,500	3,638	500	Small quantity sold; California.
Beryl, aquamarine, blue, pink, etc.	9,000	6,435	7,485	1,660	52 pounds; California, Colorado, and Maine.
Californite		a 25,000		a 18,000	3,000 pounds; California.
Catlinite		25			No production reported.
Chiastolite	25	20			Do.
Chlorastrolite			25	2,400	Shores of Lake Superior in Michigan.
Chrysocolla		150	600	300	Southwestern States.
Chrysoprase	a 32,470	a 46,500	a 48,225	a 84,800	21,200 pounds; California and Arizona.
Cyanite		100			No production reported.
Diamond		a 2,800	a 2,100	2,033	About 460 specimens; Arkansas.
Diopside	5		120		No production reported.
Emerald		a 1,320		a 300	About a dozen crystals; North Carolina.
Epidote		60		15	15 pounds in pebbles; Colorado.
Feldspar, sunstone, amazon stone, etc.	100	1,110	2,850	a 2,700	8,000 pounds; Virginia and Colorado.
Garnet, hyacinth, pyrope, almandine, rhodolite.	3,000	6,460	13,100	1,650	76 pounds; mostly hyacinth; California.
Gold quartz		1,000	1,010		No production reported.
Jasper		675		100	200 pounds; California.
Opal		180	50	200	Nevada.
Peridot	2,400	1,300	1,300	300	Arizona.
Phenacite	250	25	95	50	Colorado.

a stimated.

Production of precious stones in the United States in 1906, 1907, 1908, and 1909—Cont'd.

	Value.				Remarks.
	1906	1907	1909	1910	
Petrified wood	150	325			No production reported.
Prase	50				Do.
Pyrite		400			Do.
Quartz, rock crystal, smoky quartz, rutilated, etc.	3,050	2,580	3,595	2,689	3,120 pounds; California, Colorado, and North Carolina.
Rose quartz	4,000	6,375	568	2,970	28,300 pounds; South Dakota and California.
Rhodocrosite		150			No production reported.
Rhodonite			1,250	125	California and New Jersey.
Ruby	600	2,000			No production reported.
Rutile		200		25	North Carolina.
Sapphire	39,100	*a*229,800	*a* 58,397	*a* 44,998	271,185 carats; Montana.
Smithsonite		800	*a* 1,200	300	New Mexico.
Spodumene, kunzite, hiddenite.	14,000	14,500	*a* 6,000	15,150	150 pounds kunzite; California.
Thompsonite			35	100	Michigan.
Topaz	1,550	2,300	4,435	512	36 pounds; Texas, California, and Colorado.
Tourmaline	*a* 72,500	*a* 84,120	*a* 90,000	*a*133,192	5,110 pounds; California, Maine, and Connecticut.
Turquoise and matrix	22,250	23,840	*a*147,950	*a*179,273	34,497 pounds; Nevada, New Mexico. Arizona, and Colorado.
Variscite, amatrice, utahlite	2,000	7,500	14,250	35,938	7,135 pounds; Utah and Nevada.
Miscellaneous gems				1,060	Apricotine, verdolite, creoline, datolite, natrolite, pectolite, apophyllite, iolite, chondrodite, etc.
Total	208,000	471,300	415,063	534,380	

a Estimated.

IMPORTS.

The importation of precious stones into the United States in 1909, as reported by the Bureau of Statistics, showed a large increase over that of 1908. The principal increases were in the imports of rough or uncut diamonds, diamonds cut but not set, and other precious stones not set. The increase in the importation of rough diamonds in 1909 amounted to over five times that of 1908 and indicates a return of the diamond cutting industry to nearly normal conditions. The importation of diamonds cut but not set was greater than in any previous year.

The following table shows the value of the diamonds and other precious stones imported into the United States from 1905 to 1909, inclusive:

Diamonds and other precious stones imported and entered for consumption in the United States, 1905–1909.

Year.	Diamonds.					Diamonds and other stones not set.	Pearls.	Total.
	Glaziers.	Dust or bort.	Rough or uncut.	Set.	Unset.			
1905	$6,851	$190,072	$10,281,111	$741	$20,375,304	$4,144,434	$1,847,006	$36,845,519
1906	104,407	150,872	11,676,529	305	25,268,917	3,995,865	2,405,581	43,602,476
1907	410,524	199,919	8,311,912		18,898,336	3,365,902	680,006	31,866,599
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

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