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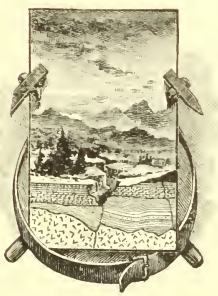

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GEMS AND PRECIOUS STONES.

By Douglas B. Sterrett.

INTRODUCTION.

There was a decrease in the production of precious stones in the United States during 1910, though the output of such matrix gems as turquoise and variscite was still large. Nearly 8½ tons of rough turquoise were produced in 1910, as compared with more than 17 tons in 1909, and more than 2½ tons of rough variscite, as compared with 3½ tons in the preceding year. New deposits of both these minerals were found in Nevada and a very promising deposit of variscite was developed near Lucin, Utah. New deposits of californite were discovered in California, and a white garnet scarcely to be distinguished from the white vesuvianite variety of californite was found in quantity in Siskiyou County, Cal. This mineral is with difficulty distinguished from white jade, for which it could well be substituted.

The output of tourmaline was considerably less in 1910 than in 1909, but a new deposit of fine gems and specimens of tourmaline was opened in Maine. The aquamarine deposits on Mount Antero, Colo., yielded a quantity of good gem material along with crystals of associated minerals, as phenacite, colorless and smoky quartz, etc. The development of the new emerald prospect in North Carolina was limited and met with only partial success. More recent work during 1911 has resulted in finds of better promise. The presence of valuable gem material has been proved, but the quantity of gems to be expected from the vein is still a matter of doubt. Further prospecting and dredge mining for the variegated sapphires of Montana were carried on, but the principal value of the sapphire production came, as usual, from the deposits of blue sapphire in Fergus County.

AGATE.

COLORADO.

A large number of agates are sold each year at the summer resorts of Colorado. Many of these agates are imported, having first been polished in Germany, but some are native stones either polished abroad or in the United States. Colorado yields some very pretty agates, and some are being successfully handled in the tourist trade. Mr. J. D. Endicott has obtained considerable agate of good quality from several places in the Canon City region. Among these are Curio Hill and the Garden Park localities.

Curio Hill.—Curio Hill is 6½ miles due south of Canon City, on the Yorkville road. It is a small hogback ridge, at the end of and transverse to a spur on the east side of the West Mountains. The hill is about 400 yards long in a direction west of north and east of south, and rises about 150 feet above the terrace country on the east, or about 6,300 feet above sea level. The locality has been known for many years and has been visited occasionally by curio seekers. No mining for agate has been carried on, but a few blasts have been put in and the soil turned over in places. The agates have been found for a distance of nearly 300 yards along the eastern slope of the hill and in a few places along the top. They are more plentiful near the middle and at the south end of the hill. Curio Hill is composed chiefly of cherty limestone, which weathers to a reddish color on exposure. The limestone is at least 60 feet thick and outcrops as a ledge along the summit of the ridge. A specimen of fossil sponge from this limestone was regarded as of Ordovician age by Dr. G. H. Girty of the United States Geological Survey. On the west of the hill is a mass of red granite of medium grain. Near the highest part of the ridge is a lens of hard, fine, white quartzite. About 175 yards east of the summit of Curio Hill a ledge of buff and red sandstone outcrops forming a small cliff. The strike of the formations on Curio Hill varies from N. 10° W. to N. 35° W. and the dip is about 75° SE. The hogback of Curio Hill is evidently formed by faulting of the limestone and quartzite against the granite. The greater part of the quartzite was cut out by a curved fault, leaving only a short slice between the granite and limestone.

The agates are found loose in the soil along the foot of Curio Hill, in the talus on its slope, and in place in the limestone ledge forming its backbone. The loose specimens have been released by the weathering of the original rock matrix, probably chiefly limestone like that along the summit of the ridge, and have accumulated on the surface with other difficultly soluble constituents of the matrix. The agate occurs in the limestone in irregular augen and ball-shaped geodes, in veins, seams, and partially filled cavities with mammillary and reniform surfaces. Fragmentary pieces are found loose in the soil. Nearly all of the agates have some banding, and some of the geodes show the "fortification" agate structure. The banding varies from coarse to very fine, and in some cases these variations appear in the same specimen. The interior of some of the geodes and cavities is lined with quartz crystals and occasionally calcite is present. The agates range in color from white to light gray, to dark gray, to yellowish red, to brownish red, to cherry red. Combinations of two or more of these colors are generally present in a single specimen. Much of the agate is translucent. The majority of the agates are not large, and specimens of the best quality measuring 2 inches across are not abundant. The delicate markings and intricate patterns exhibited by some of the agates has led to their being called "fancy agates." The natural colors of many of the agates from Curio Hill are sufficiently pretty not to require intensification by burning and other treatment.

Garden Park.—Agate and jasperized bone are found at the dinosaur fossil bed locality, 7 miles due north of Canon City, on the south side of Garden Park. The deposits are in the rough hills on the west side of Oil Creek. The jasperized bone horizon is a few

hundred feet above that of the agate. This occurrence was mentioned in this report for 1908 and reference was made to a more widespread occurrence of similar agates as noted by Willis T. Lee.[1] An examination of the dinosaur bed locality places the agate horizon near the base of the Morrison formation,[1] of Jurassic (?) age. The soft shales of the upper part of this formation have yielded many dinosaur fossils for museum collections. The bones of these animals have been petrified by siliceous material, producing red, brown, and yellow jasper, with gray and white matrix, consisting in part of chalcedony. The replacement of different parts of the bone tissue by minerals with different colors has produced a variety of effects. The structure of the bone is shown up well by the spots and mottlings of dark jasper in lighter-colored matrix. Some of the petrified bone polishes well and makes a handsome ornamental stone and some is sufficiently pretty to use in jewelry. Much of the bone has been replaced by minerals of variable hardness and is therefore difficult to polish evenly. Fragments of the bone are scattered over a considerable area, and specimens several inches across are not uncommon.

The fancy agates occur in a loose gray and red to purple clay shale, in which are included occasional beds of sandstone and limestone. Concretions of limestone and seams of calcite also occur in the same formation. The calcite seams have the structure of satin spar and some are delicate pink. The agates occur in the form of geodes, seams, and rough segregations. Some of them have replaced other minerals and organic material. A small gasteropod shell, petrified by carnelian-colored agate, was found at this locality, and was identified as *Valvata leei* by Willis T. Lee, for whom the species was named by W. N. Logan.[2] Such shells would make unique stones for scarf pins if they could be found in greater quantity. The agates from this locality are small. Their bandings, marking, and patterns are very delicate and beautiful, and the colors are varied and bright. Fortification agate is a common variety and yields widely varying effects when cut. The colors vary through white, gray, different shades of yellow, orange, brown, blood red, and cherry red. The different colors are often present in the same specimen and, combined with the extremely delicate bandings and odd patterns of the agate, yield a remarkably pretty gem stone. A beautiful variety is the St. Stephen stone—a translucent chalcedony with round blood-red spots through it. The natural color of the fancy agates from this locality probably could not be improved by artificial treatment, so commonly necessary with agates from other localities.

NEVADA.

Specimens of chalcedony and agate were kindly sent to the Survey by Mr. M. M. Holland, of Coaldale, near which place they were found. The specimens consist of mammillary shells and lumps of highly translucent grayish chalcedony up to an inch in thickness and of greater breadths. The chalcedony is very pure and even textured.

[1] The Morrison shales of southern Colorado and northern New Mexico: Jour. Geology, vol. 10, No. 1, 1902, p. 44.

[2] The stratigraphy and invertebrate faunas of the Jurassic formation in the Freezeout Hills of Wyoming: Kansas Univ. Quart., April, 1900, p. 133.

A dark-greenish coating with a white border is attached to one side of some of the specimens. One specimen shows a white onyx banding.

Mr. Louis Sigmund, of Mina, Nev., reports the discovery of a vein of chalcedony, semiopal, and common opal, about 2 miles southeast of Redlich in a granite formation. Specimens kindly furnished consist of very translucent gray chalcedony and milky-white opal. The vein of chalcedony is said to be from 2 to 6 inches in thickness.

TEXAS.

Prof. Johan A. Udden, of Rock Island, Ill., reports observing agates in the hills directly west of Hancock's ranch, about 18 miles north-northeast of Alpine, Tex. The agates are fairly plentiful and range in size from 1 to 3 inches in diameter. They are marked with concentric bandings.

ARIZONA.

Mr. John L. Riggs, of Chloride, Ariz., states that much chalcedony and opalescent chalcedony is found in Mohave County. This material would cut into stones similar to the chalcedony called moonstone found on the California beaches. Some banded chalcedony or agate is found, also some tinted with blue and pink.

AMBER.

PRUSSIA.

Notes on the amber deposits on the Baltic owned by the Prussian Government have been given by O. H. Hahn.[1] The deposits occur all along the coast of the Baltic from Danzig, West Prussia, to Memel, East Prussia. The most productive region of present times is along the coast from Palmnicken north to Brüserort Lighthouse and then east to Neukuhren. The amber industry is an ancient one, for the mineral was gathered by fishermen in early times. The ownership of the deposits is vested in the State and rights were formerly leased. The industry has proved very profitable to the State. Amber was later obtained by mining methods, and now probably only one-twentieth of the output is obtained by search and by fishing. Mining has been of three kinds—large open-cast pits, underground mining, and dredging. At present the greater part of the amber is obtained by sinking shafts to the productive stratum and then tunneling out on it. It is said that the quicksands overhead are giving much trouble and that it may be necessary to return to open-cast methods. The principal shaft is near Palmnicken, and is said to be about 60 feet deep and to have about 2 miles of drifts from it. The amber-bearing bed is a stratum of bluish-gray sandy clay, locally called "blaue Erde."

The crude amber from the mine is washed in revolving barrels and scoured with rattan brushes to remove clay and impurities. The amber floats to the surface and is skimmed off. After cobbing it is sacked for shipment to Konigsberg, where the State disposes of it after careful sorting. Large pieces of amber are not common. A specimen weighing 15 pounds has been found, and another of 8½ pounds

[1] Eng. and Min. Jour., Apr. 8, 1911.

is now in a museum. The production of crude amber amounts to about 350 metric tons per year. Statistics for one year showed that 712,086 mine cars of "blaue Erde" yielded 386 metric tons of amber.

The smallest pieces of amber are manufactured into fused amber or resin, amber oil, and succinic acid. Good grades of amber are welded by heat and pressure into solid masses called "amberoid." Large quantities of crude amber go to Polangen and Kretinga, border towns in Russia, for manufacture into ornaments as rosaries, necklaces, cigar-holder tips, etc. In 1910 the Government authorized the sale of 55,000 kilograms of raw amber and 22,000 kilograms of compressed amber, at a value of $788,357.

AMETHYST.

DEPOSITS.

Amethyst has been found at several localities in Macon County, N. C., and in Rabun County, Ga., to the south. Some of the deposits have been opened as mines and others have been prospected only or worked intermittently. At present none of them is in operation. Several prospects and mines have been opened in the valley of Tessentee Creek, in North Carolina, and other deposits have been found a few miles southeast of these, on the south side of the Blue Ridge. Of the deposits in Georgia some are in the vicinity of Clayton and others are about 5 miles south of Highlands. Of the deposits in the valley of Tessentee Creek, the Connally mine has been worked by the American Gem & Pearl Co., New York, and the Rhodes mine by the Passmore Gem Co., Boston. Other prospects for amethyst in North Carolina are located on the lands of William Long, John Justice, and J. B. Justice.

NORTH CAROLINA.

Connally mine.—The Connally mine is on the north side of the valley, about 2 miles N. 55° E. of the mouth of Tessentee Creek, in Macon County. The workings extend over 100 yards northward up a steep mountain side, from an elevation of about 2,600 feet to nearly 2,800 feet above sea level. They consist of prospect pits and tunnels with irregular stopes. Some of the tunnels are over 100 feet long.

The country rock is garnetiferous mica gneiss cut by fine biotite granite gneiss, in both of which pegmatite occurs. The strike of the gneiss as measured in some of the openings was N. 10° to 35° E. and the dip was almost vertical. The amethyst vein cuts across the gneiss with a strike of N. 40° W. and a vertical dip. Local variations in strike occur where the vein follows irregular contacts between the garnet gneiss and the granite gneiss, which, in these places, form the walls of the vein. In other places the vein lies either in garnet gneiss or in granite gneiss. In most of the openings the vein consists of a single seam with pockets of amethyst crystals at irregular intervals. The pockets are more or less lenticular in shape and range from 1 to 12 inches in thickness, and from a few inches to several feet in length. Many of the pockets are filled with yellowish-red and dark-red clay, though some contain cavities. The amethyst crystals line the walls of the pockets, have become detached and lie loose, or are imbedded in the clay of the pockets. Portions of the vein with

the pockets and seams joining them form channels for a small flow of water in wet weather, which probably furnishes the clay of the pockets by decomposing the rock along its course. In one prospect two veins were exposed, cutting decomposed granite gneiss. The granite gneiss along one of these veins was more decomposed and more heavily stained with iron than that adjoining the other. The vein in the decomposed rock contained much yellowish-red clay with some amethysts of a fair color. In the other vein only pale amethystine quartz crystals were found.

Seams of small quartz crystals, sometimes in pockets, branch out from the main vein in places, though no amethysts were observed in them.

The amethyst crystals range from a fraction of an inch to over 2 inches in thickness. Most of them have only a pale amethystine color and some are nearly colorless quartz. The purple color of the amethysts is not uniform throughout the crystals, but is generally richest near the points and is often arranged in layers of varying intensity parallel with the crystal faces. Only a small percentage of the crystals yield very dark-purple gem material that will cut into stones weighing several carats.

William Long prospect.—The William Long prospect is between two prongs of the headwaters of Tessentee Creek, 4½ miles east of its mouth. An open cut 30 feet long in an east and west direction with a maximum depth of 8 feet was made on a vein of amethysts. The country rock is granite. The granite on the north side of the cut is partly altered, somewhat porphyritic biotite granite. The granite on the south side and closely connected with the amythyst vein is badly altered and is pinkish yellow. In thin section under the microscope the following minerals were observed in this rock: Quartz in irregular grains and veinlets, muscovite, aggregates of fine decomposition products, apparently sericite, replacing original feldspars, and hematite stains. This rock is probably an altered form of the country granite. The amethyst vein is reported to vary from less than an inch to 8 inches in thickness, and to have an east-west strike with a high northerly dip. No work was in progress at the time of examination, and only the poorer specimens of amethysts were seen on the dump. These consisted of crystals ranging from a fraction of an inch to 1½ inches in thickness. They were mostly pale amethystine in color, though fairly dark-purple crystals are reported to have been found.

Amethyst is reported to have been found on the land of John Justice, about two-thirds of a mile southeast of the Long prospect, and on the land of J. B. Justice, about three-fourths of a mile southwest of the Long prospect.

GEORGIA.

Ledbetter amethyst mine.—The Ledbetter amethyst mine is on Black Creek, 1 mile north of east of Rabun Gap, Ga. The principal workings are on the south side of the creek, and consist of an open cut about 20 feet deep with a shaft 20 feet deep from its bottom, connecting with a crosscut tunnel driven to the vein from the hillside below, a tunnel from the level of the open cut on the vein, and three pits within a distance of 35 yards to the northwest. The country rock is a

gneiss that may be flow banded granite or a mica gneiss injected with granitic material, and is badly decomposed and soft. The amethysts are found in one or more veins, which strike about N. 25° W. with a dip of 80° to the southwest. As exposed in one of the workings the vein varies from a seam a small fraction of an inch to over 2 inches in thickness. In another opening there is a double seam with crushed rock and clay between. Where the vein does not carry amethyst crystals it is represented by a seam containing a black stain. Amethysts of good color were found in this deposit.

About 150 yards N. 25° W. of these workings three other small open cuts have been made in the same general direction. The country rock is the same as at the other workings. A number of pale amethyst crystals were seen on the dumps around these pits.

North Georgia Co. mine.—Amethyst has been worked on the land of the North Georgia Co., 4 miles (by road) north of west of Clayton, Ga., on the south side of the Blue Ridge Mountains at an elevation of about 2,800 feet above sea level. The work consisted of an open cut 50 feet long on an amethyst vein, and another cut with a tunnel 60 yards to the northwest. Other prospect pits have been made within 150 yards to the northwest. The country rock is gray granite gneiss, which has a westward strike and low northward dip. There is more than one seam or vein yielding small crystal quartz, but in how many of them amethyst was found could not be ascertained. The crystal quartz veins and amethyst vein have a northwest strike. Only quartz crystals with a pale amethystine color were seen on the dumps, but good gems are reported to have been found during the working.

John A. Wilson amethyst prospect.—A few amethysts have been found on the land of John A. Wilson, 4 miles (by road) southeast of Clayton. The country rock is mica gneiss, inclosing some pegmatite, and striking northwest with a northeast dip. The amethyst vein is accompanied by a silicified zone of rock which cuts the gneiss with a northeast strike and a nearly vertical dip.

TEXAS.

Mr. N. J. Badu, Llano, Tex., has kindly furnished the following notes on the occurrence of amethyst in Llano County. Very little work has been done on any of the deposits and the discoveries so far are not thought to have much value. Few if any crystals have been used as gems. Occasional veins or pockets in soapstone are found that yield 20 to 25 pounds of crystals. A few crystals as large as a man's thumb have been found, but most of them are smaller. Some have a good, deep purple color, but few are very clear.

BERYL.

NORTH CAROLINA

Joel Walker beryl prospect.—The Walker beryl prospect is on a knob one-half mile east of Walker Knob of the South Mountains, 8 miles west of south of Morganton, Burke County, N. C. Beryl crystals have been found at two places here about 200 yards apart. One of these has been opened by a pit 10 feet deep and 18 feet long. This

pit is along a pegmatite body striking north and south with an easterly dip. The country rock is mica gneiss cut by granite and has a northeasterly strike. Black tourmaline and small sheets of mica are associated with the beryl in the pegmatite. Both aquamarine and green and golden beryl were found in this opening. At the other locality numerous small yellow and golden beryls up to the diameter of a pencil in size have been found in bowlders of pegmatite on the mountainside. Some of these crystals are clear and have very rich colors. Much of the beryl observed from these deposits was rather badly checked and flawed, though some crystals were seen that would yield cut gems of about a carat in weight. Larger clear stones are reported to have been found. From the small amount of development the showing seems favorable.

Other beryl prospects have been found in the South Mountains. One prospect, a mile east of the Walker prospect, has yielded crystals of good aquamarine color and three-fourths of an inch in diameter, with portions clear enough for cutting.

Littlefield beryl mine.—The Littlefield beryl mine is on the headwaters of Tessentee Creek, 1 mile south of Whiterock Mountain, Macon County, N. C. The last work at this mine was in 1902. The vein was removed by an open cut 135 feet long and from 10 feet deep at the northeast end to 25 feet deep at the southwest end. Another open cut 20 feet long and 10 feet deep, a few feet southwest of the main one, showed that the vein had been offset about 6 feet to the west. The country rock is biotite granite gneiss, porphyritic in places, and strikes N. 40° E. with a 40° SE. dip. The beryls were found in a pegmatite ledge cutting across the granite gneiss with a strike of N. 40° E. and a dip of 85° SE. The greater part of the pegmatite removed in the open cut varied from 3½ to 5 feet in thickness. At the southwest end of the cut the pegmatite pinches down to 8 inches in thickness. Clear aquamarine green and golden beryl, ranging from needlelike specimens to three-fourths of an inch in diameter and 2 or more inches in length, was obtained at this mine. These crystals furnished very beautiful gems as well as some good specimen material.

Beryl crystals are found on a ridge near the house of R. E. Brown, 1¼ miles S. 25° E. of the point where Johns Creek and Caney Fork join in Jackson County, N. C. A small pit was opened in search of mica on the outcrop of a partly decomposed pegmatite. About a dozen beryl crystals were found in this pit. The crystals ranged up to nearly 1 inch in diameter and 2 inches in length. Some of them were transparent in places and of a fairly good aquamarine color. If crystals with larger clear portions and of the same color could be found, they would be suitable for gems.

The beryls are found in kaolinizing feldspar, associated with quartz and a little black tourmaline. The country rock is mica gneiss, badly decomposed, with which the pegmatite seems to be conformable. To the west a short distance is a band of staurolite schist, and to the northeast chloritic soapstone.

GEORGIA.

Beck beryl mine.—The Beck beryl mine is 7 miles due east of Clayton, Ga., a mile or two south of War Woman Creek. The work consists of an open cut 120 feet long and 10 to 15 feet in depth, with three side entries on the downhill side. The country rock is mica

gneiss which strikes N. 70° E. and dips 25° N. There are small intrusions of hornblende gneiss in the mica gneiss, and the mica gneiss has local variations of dip and strike around them. The beryl occurs in pegmatite which cuts the gneiss with a north and south strike (dip undetermined). The pegmatite ranges from 6 to 12 feet thick. It carries mica crystals up to 6 and 8 inches in diameter as well as beryl. Much of the mica plates show the "A" structure, though good sheets could be obtained between the "A" lines. Fragments of translucent to subtransparent rough quartz crystals were found in the pegmatite. Bluish, bluish-green, and yellowish-green beryls were found. Some of these measure several inches across and, though badly flawed, contained clear portions suitable for cutting.

NEW YORK.

Mr. Wallace Goold Levison, Brooklyn, N. Y., has kindly furnished the following information on a recent find of aquamarine beryl in New York. The specimens were found by James G. Manchester, 32 Nassau Street, in the Borough of Manhattan. They were obtained in the form of broken fragments without crystal faces and were cut into clear light-blue or greenish-blue aquamarine. One stone of over a carat in weight was cut, but the others were smaller.

UTAH.

The discovery of blue beryl near Ibapah, Utah, is reported by Maynard Bixby, Salt Lake City, to be entirely as float material. Some of the specimens submitted to Mr. Bixby gave evidence of a deposit of gem mineral.

CALIFORNITE (VESUVIANITE).

CALIFORNIA.

Siskiyou County.—The occurrence of massive compact vesuvianite in Siskiyou County, Cal., has been described by George F. Kunz,[1] and the name "californite" was given to it after its native State. The deposit was located by Dr. A. E. Heighway for L. Tannenbaum, of New York. Mr. Amos Clausen, superintendent for the present owners, states that the occurrence of the mineral was known to him before it was located by Dr. Heighway, but that its possible gem value was only partly recognized. The mineral was first called jade, being mistaken for nephrite, until an analysis by F. W. Clarke and George Steiger, of the United States Geological Survey, showed it to be essentially vesuvianite. Massive compact vesuvianite has been found at two localities in the Alps and was there mistaken for jadeite until identified by a chemical analysis by Berwerth. The original locality in California is at present owned by D. C. Collier and S. F. Smith, of San Diego.

The deposit is at an elevation of about 1,700 feet above sea level, on the South Fork of Indian Creek, about 10 miles west of north of Happy Camp. The South Fork of Indian Creek has a northeasterly course and joins the main creek about 2½ miles below the mine. The creek flows east for a short distance at the mine, and is in a narrow valley with steep sides. A good road was made to the mine, but

[1] Gems, jewelers' materials, and ornamental stones of California: Bull. State Min. Bur. California No. 37, 1905, pp. 93–95.

has been broken down by hillside slides in two places. The country is well timbered and watered. The californite outcrops on the north side of the creek on a steep hillside about 75 feet above the water.

The country rock is principally serpentine, varying in color from gray, green, yellowish-green, greenish-black, to black. The serpentine is full of slickenside seams and joints and has been broken and sheared into lens-shaped blocks and masses. These lenticular-shaped bodies range from a fraction of an inch to several feet in thickness and length. Streaks and lens-shaped masses of a granular gray rock are included in the serpentine in the region near the californite deposit. By alteration, not surficial, these rocks assume a greenish cast and appear to grade into californite. The outcrops of this rock measure 20 feet across in places and range down to streaks a few inches in thickness. The californite occurs in lens or pod shaped masses in the serpentine. The lenses follow the bedding of the serpentine and occur at irregular intervals. They range in size from a few inches to 10 feet in thickness and their length is probably two to four times their thickness. The lenses are not regular in shape, but in some cases pinch out and swell or are curved. The several outcrops of the californite in a line along the hillside give the appearance of a vein or ledge of this material. The strike of the californite and inclosing serpentine is about northeast and the dip 10° to 40° NW. About half a mile below the mine a mass of dense bluish-black rock is inclosed in the serpentine. Under the microscope this is found to consist largely of quartz penetrated by innumerable needles of blue glaucophane.

The californite has been traced nearly 100 yards from the main outcrop along the hillside in a north-of-east direction. The principal work consists of an irregular open cut, or set of cuts, nearly 200 feet long on the lower side of the outcrop with two short tunnels in and under the masses of californite. Several pits have been made farther east. A number of large masses of californite lie in Indian Creek below the deposit, from which large blocks have become detached and rolled down. They have since been rounded into bowlders by attrition in the creek. These bowlders range in size up to 6 feet long and 3 feet thick, and have yielded some very good grade of gem material. There is considerable matrix associated with the californite in the bowlders as well as in the original deposits. The grade of the californite is also quite variable, even in the same masses, some being translucent light to dark green, and others opaque greenish-gray to gray. The californite is associated with both granular gray rock and with serpentine. It is attached to both rocks and in places appears to grade into either. In some places the californite occurs in masses over a foot thick with good color and translucent. Masses of poorer grade are in some places several feet across. Seams and joints or cracks are common in all varieties of californite, so that masses of good grade several inches thick without flaws are rare. Many of the cracks have been recemented or were not sufficiently pronounced to weaken the mineral materially so that the californite can be cut regardless of them, if large pieces are desired for ornamental use. Other seams are due to joints strongly developed, with or without a deposit of other mineral on them, forming planes of easy fracture in the californite. The californite is grayish green to yellowish green to dark green and some has almost a bright-green color. Much of it is translucent and some of the better grades are highly so. In

places the translucency is slightly clouded. The bright green generally occurs in splotches and tufts through paler-colored mineral. In places the patches of green are so plentiful that whole masses of the californite are strongly colored. Californite is very tough and has a hardness of about 6.5. The specific gravity of the Siskiyou County californite is 3.286, nearly as great as jadeite and greater than jade or nephrite. The specific gravity of material from Fresno County is 3.359. It takes a high polish and is adapted to many purposes for which jade is used. The flocculent appearance and texture of the californite increases the resemblance to jade.

Henry Wood, of San Francisco, and Justice Brown, of Happy Camp, own a claim for californite adjoining that of Collier and Smith on the northeast. Outcrops of large ledges of altered granular gray rock have been blasted into in search of gem material. They own two principal ledges of the rock outcrop, one at about 50 feet higher than the creek and the other about 100 feet. The country rock is the same variety of serpentine as at the mine just described. The outcrops of the gray parent rock of the californite are from 10 to 20 feet thick and are lenticular in shape. Large portions of this rock have a greenish color and are composed of finely fibrous mineral in a felted mass. Much of the californite at this prospect is low grade, but some fairly good colored translucent material was seen on the dumps.

Specimens of white californite, given by Mr. A. Clausen, of Happy Camp, were described in this report for 1909. The material was obtained from bowlders found in Indian Creek. Specimens of the same variety of californite were recently received from Mr. Felix Busse, Happy Camp, and may have come from the same locality. They were evidently broken from bowlders, as some of the specimens show surfaces worn by attrition. The material is quite translucent and has a waxy luster. The color is pure grayish white to gray with a faint tinge of green and an occasional patch of grass green. The fracture, hardness, grain, and toughness are the same as in the green californite, and the mineral ought to be a good substitute for white jade, which it closely resembles and which is in demand by the Chinese. If material in which the bright green patches were more plentiful could be found, it would rival the best qualities of jade. It is not possible definitely to distinguish the massive white variety of vesuvianite from massive white garnet without a detailed chemical analysis, since the two minerals are so similar in both physical and chemical properties. Analyses of the vesuvianite variety of californite and white garnet by Clarke and Steiger [1] bring out the similarity, but indicate a possible method of discrimination without a detailed analysis by the presence of from 3.42 per cent to 4.18 per cent of water in the vesuvianite, and of 0.80 per cent of water in the garnet. A determination of the water content by ignition, by Dr. R. C. Wells, of the United States Geological Survey, gave 1.38 per cent in the white californite given by Mr. Clausen and 1.05 per cent in that given by Mr. Busse. The results are not conclusive, but are indicative of garnet rather than vesuvianite. The specific gravity of the vesuvianite variety of californite is given as from 3.286 to 3.359 and that of white garnet as 3.586. A determination of the specific gravity of the

[1] Clarke, F. W., and Steiger, George, On "californite:" Bull. U. S. Geol. Survey No. 262, 1905, pp. 72–75.

Siskiyou County white mineral, by Dr. J. E. Pogue, of the National Museum, gave 3.57—further evidence in favor of garnet. The minerals, garnet and vesuvianite, may be so intimately mixed in some varieties of californite that an absolute determination is not possible. The idea of the development of two minerals with such similar properties and composition together seems within reason. The term californite may be used both for massive compact vesuvianite and for garnet when these can not be readily distinguished.

Butte County.—A deposit of californite was worked by the North California Mining Co., of Oroville, near Pulga post office or Big Bar station on the Western Pacific Railway near the Butte-Plumas County line. E. A. Jackson, vice president of the company, states that the deposit is in the southwestern part of T. 25 N., R. 8 E. Considerable crude californite was mined during 1910, but a small per cent only was suitable for cutting. The demand for californite for jewelry was limited and the quantity sold was not large. Specimens of the californite, kindly furnished by Mr. Jackson, were translucent apple green, showing in places a few darker green patches. The color is not so dark as that of the Siskiyou County californite, and resembles closely some of the Fresno County variety. The color is rather evenly distributed and pleasing. A better trade for the material has been reported during the first part of 1911.

DIAMOND.

ARKANSAS.

The following notes are abstracted from an article by John T. Fuller,[1] general manager of the Arkansas Diamond Co.:

Contrary to expectation there was but little development on the company's property during 1910, due to continued lack of capital. The production of diamonds in the Arkansas fields amounted to about 200 stones, all of which came from the one peridotite outcrop, the greater part of which is controlled by the Arkansas Diamond Co. The total production to date is estimated at about 1,200 stones, weighing approximately 574 carats. Of this production 1,179 stones came from the original peridotite area. During 1910, 145 loads of earth of 16 cubic feet were washed in a small test plant at the mine, and yielded 142 diamonds weighing 53.56 carats, or an average of 0.369 carat per load. In addition, 44 stones weighing 20.5 carats were picked up on the surface. The outlook for extensive development in 1911 is not promising.

Mr. Reece Lamb, first vice president of the American Diamond Mining Co., gives the following information about diamonds found on the company's land:[2]

Twenty-two diamonds have been found, 7 in 1908 and 14 in 1909, with 1 stone found by an outside party in the latter part of 1908 or early in 1909. No diamonds were found on the property during 1910. The area of the peridotite has been proven, but no washing machinery installed.

In regard to the holdings of the Kimberlite Diamond Mining Co., Austin Q. Millar [3] says:

"Kimberlite" rock has been found on the property about one-fourth of a mile west of the American Diamond Mining Co.'s mine. Mr. Millar claims that sworn statements were made by Oliver Cummings Farrington and Philip F. Schneider to this effect at Murfreesboro in 1908. A few small diamonds have been found, but all were white stones. No washing has been undertaken and the property is being tested to determine the size of the peridotite.

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[1] Eng. and Min. Jour., Jan. 7, 1911.
[2] Personal letter, dated Murfreesboro, Ark., Jan. 30, 1911.
[3] Personal correspondence, dated Apr. 4, 1911.

CALIFORNIA.

A number of diamonds have been found in California, especially in Butte County, and some of the discoveries have been described.[1] Several diamonds were reported as being found during 1910 in the Cherokee Flats region, and two of these were mentioned in this report for 1909. One of these two diamonds weighs about half a carat and the other between $1\frac{3}{4}$ carats and 2 carats. The latter is a brilliant, clear, flawless stone with a tinge of yellow. It is a much rounded crystal with curved faces, either a trisoctohedron or hexoctohedron. This diamond was kindly shown to the writer by Mrs. James, of Cherokee. Both diamonds were found among the old hydraulic workings during placer mining on the land of T. L. Vinton, by a miner named George Stone. The residents of Cherokee Flats state that over 200 diamonds have been found which have generally been picked up by parties interested only in gold.

All the diamonds so far found in California have come from gravel deposits. Search for diamonds in the original rock matrix has been carried on by the United States Diamond Mining Co., of Oroville, under the direction of M. J. Cooney. This company owns property near Oroville, at Cherokee Flats, and at other places in the region. The principal work has been on the property about 1 mile north of Oroville. This consists of about 40 acres in part covered by alluvium, 10 to 15 acres having been stripped off by earlier hydraulic mining. Developments by the present company consist of a 300-foot shaft, a 60-foot shaft, and numerous small pits. To facilitate hydraulic mining in the early days a drainage tunnel was cut from the placers under bedrock to the bank of Feather River. This tunnel was used to remove the débris from mining and is still open. Several small diamonds are reported to have been found on this property, but none were kept in the possession of the company.

The alluvium has a thickness of about 50 feet in places and has been left standing in walls around the old placers. The bedrock now exposed is decomposed and is yellowish gray in color. In the excavations it is observed passing into bluish to greenish rock. Tufa-like segregations and balls of limestone occur in the decomposed rock and give place to calcite seams in the less altered rock below. At the mouth of the drainage tunnel a decomposed sedimentary rock is exposed, carrying brachiopod fossils so badly weathered as to be indeterminate.

Prominent among the rocks of the Oroville region, as mapped by Turner, Lindgren, and Becker,[2] are a series of amphibolite schists derived from various basic rocks as gabbro, diorite, diabase, etc. Some augite porphyrite is included in the schists. These rocks are older than late Cretaceous. From the bridge north of Oroville a section along Feather River and the Western Pacific Railway track reveals rock formations answering the above description. The formation on the property of the United States Diamond Mining Co. is very similar in appearance to that observed along the river, and some of the less decomposed material from the shafts appears to be identical. Specimens from both places are considerably serpentinized and

[1] Turner, H. W., Diamonds in California: Am. Geologist, vol. 23, 1899, p. 182.

[2] Marysville folio (No. 13), Smartsville folio (No. 18), and Bidwell Bar folio (No. 43), Geol. Atlas U. S., U. S. Geol. Survey.

contain epidote, zeolite, etc. In thin section under the microscop some of the specimens show basic feldspars in various stages of alter ation and enough of the minerals and texture could be identified t class the original rock as gabbro in some cases and diabase in others The general appearance of these rocks resembles serpentine, and th weathering, also, is similar to that of serpentine.

The property owned by Mr. Cooney and his associates at Cheroke Flats includes a number of acres of old placers where a quantity o diamonds are reported to have been found. Prospect pits and a 60- foot shaft have been made. The shaft encountered banded black slate. Buff to gray sandstone and slate outcrop in other parts of the old placers. These sedimentary rocks appear to be interbedded with diabase and amphibolite. The latter rock, in certain places, is very similar in appearance to the rock of the Oroville region. It outcrops in large flattened spheroidal bowlders of weathering.

Since the presence of diamonds is well established in Butte County, the original matrix remains to be located. The recent discovery of diamonds in peridotite in British Columbia may furnish a clue as to the nature of the rock to be examined for diamonds in California. It has never been proved that a peridotite is the only type of rock in which a diamond can occur, and some of the other basic rocks of California may prove to be diamondiferous. However, the serpentinized amphibolites may contain masses formed from original peridotites or allied rocks that have served as a matrix of the diamonds found in the placers. The possibility of reworking the old placers for diamonds ought to be considered, also, for they have never been tested with this in view. Mining operations heretofore were adapted only to the saving of gold, and only an occasional diamond was caught in the riffles of the sluice boxes.

CANADA.

The discovery of diamonds in British Columbia has been announced by R. W. Brock,[1] director of the Canada Geological Survey. Charles Camsell, of the Canada Geological Survey, was engaged in a geological examination of the Tulameen River region and submitted samples of chromium ore from Olivine Mountain to R. A. A. Johnston, a mineralogist of the Canada Survey, for determination of the chromium minerals. During the investigation Mr. Johnston obtained fragments of an insoluble mineral which proved to be diamond. The specimens separated have all been small or microscopic in size, but under the microscope many appear to be clear and of good quality, but some are yellow and brown. The diamonds have been found in chromite which occurs in small irregular veinlike segregations and disseminated grains through the olivine rock. Gold and platinum also occur in the chromite. The peridotite with which the diamonds are associated is altered to serpentine in places, thus giving a matrix somewhat similar to that in which diamonds have been found in Africa and Arkansas.

Dr. Brock obtained small crystals thought to be diamond from British Columbia several years ago, but the material was lost before complete tests could be made, and the results were therefore not

[1] The Citizen, Ottawa, Canada, Mar. 16, 1911.

published. The prospectors were given a hint at that time, however, to be on the lookout for diamonds in British Columbia. The discovery is regarded as of scientific interest only, but the possibility of finding larger stones in the gravels should not be overlooked.

SOUTH AFRICA.

Cape Colony.—The output of diamonds by the De Beers Consolidated Mines [1] shows a large increase in 1910 over the two preceding years. Although no statement is given of the number of carats of diamonds produced in 1910, estimates based on such figures as are given show an output of approximately 2,661,223 carats, as compared with about 1,863,838 carats in 1909. These estimates are based on the number of loads of blue, cylinder lumps, and tailings washed from each mine and the yield per load. During 1910, 5,684,156 loads of blue were washed, as compared with 4,774,172 loads in 1909. The total production of blue ground in 1910 was 5,111,524 loads, as compared with 3,557,975 loads in 1909. The stock of blue ground and cylinder lumps was reduced from 9,526,531 loads in 1909 to 7,776,059 loads in 1910. The value of the diamonds sold and of stocks on hand at cost of production was £5,414,896, as compared with £3,074,912 in 1909. The value of the diamonds produced in 1910 is less than that of 1907 by £1,037,701. The De Beers and Dutoitspan mines closed down during 1908. Work on the Dutoitspan was resumed in January, 1910, but work on the De Beers mine has not yet been resumed. Blue ground from the floors of all the mines, including the De Beers mine, was washed. The yield in carats per load of blue washed decreased from 0.42 to 0.38 at the De Beers and Kimberly mines, from 0.34 to 0.32 at the Wesselton mine, and from 0.38 to 0.37 at the Bultfontein mine. The yield per load of blue washed at the Dutoitspan mine was 0.23 carat, the same as in 1908.

Attention is called to the fact that in value the De Beers company produces 48 per cent of diamonds mined in South Africa, including German Southwest Africa. The Jagersfontein mine produces 7 per cent, the Premier less than 20 per cent, and other companies, including the river diggings, produce the remaining 25 per cent of the value of the output.

The total production of diamonds in Cape Colony [2] in the calendar year 1909, reported by the detective department, amounted to 2,527,297 carats, valued at £4,690,478, as compared with 1,588,511 carats, valued at £3,085,352 in 1908. This production came from the districts of Kimberly, Barkly West, Hay, and Herbert, and from alluvial diggings on Vaal River.

Transvaal.—According to Consul Edwin N. Gunsaulus,[3] of Johannesburg, the annual report of the Premier Diamond Mining Co. for the year ending October 31, 1910, showed a production of 2,145,833 carats of diamonds, valued at $7,283,398, or a value of $3.39 per carat. An average yield of of 0.23 carat per load, valued at 78½ cents, was obtained from the 9,331,882 loads of earth washed. The profits for the year amounted to $2,633,709, of which 60 per cent is claimed by the Government. The production shows an increase over 1909 of 73,696 carats in quantity and of $1,578,020 in value.

[1] Twenty-second Ann. Rept. De Beers Consolidated Mines for year ending June 30, 1910.
[2] Report Surveyor General Cape of Good Hope, 1909; Dept. of Agriculture.
[3] U. S. Daily Cons. Repts., Apr. 11, 1911.

German Southwest Africa.—The production of diamonds in German Southwest Africa in 1910 is estimated by Consul General Henry W. Diedrich,[1] of Antwerp, at about 800,000 carats, with a value of about $6,000,000. Official figures of the German Diamond Regie,[2] however, show a production of only 92,619 carats for the third quarter of 1910. The majority of the German diamonds go to Antwerp, but a few are now being cut in Amsterdam. Some are cut in Germany. Competition of the German diamonds and those from the Premier mine with the product of the De Beers mines has resulted in a reduction in the price of low-grade stones and of bort for industrial purposes. Bort diamonds, formerly sold for $1.67 to $1.90 per carat, have been reduced to about $0.60 per carat.

According to Herr Baderman, in the Deutsche Goldschmiede Zeitung,[3] an analysis of the color of 1,558 German diamonds gave the following results: Clear, or with a slight yellowish tinge, 819; delicate yellow, 136; lemon yellow, 87; light pink, 116; dark red, 9; bluish, 30; greenish, 5; blackish, 9; showing various colors, 68; impure or turbid shades, 62; split diamonds, white or pink, 217. The German Southwest Africa diamonds do not present any marked difference from those of South African diamonds generally, with the exception of size.

SOUTH AMERICA.

British Guiana.—The exports of diamonds from British Guiana[4] during the calendar year 1910 amounted to 3,808 carats, valued at $30,946, as compared with 5,646 carats, valued at $36,069 in 1908. The value given the production of 1909 in a previous report was $39,060.

INDIA.

The production of diamonds in India[5] in 1909 amounted to 147.35 carats, valued at £1,089, as compared with 140.75 carats, valued at £940, in 1908. Of the production in 1910, 111.37 carats, valued at £47, came from the Madras Presidency and the remaining 35.98 carats, valued at £1,042, from the Central Indian States.

AUSTRALIA.

New South Wales.—The production of diamonds in New South Wales[6] during 1909 amounted to 5,474 carats, valued at £3,959, as compared with 2,205 carats, valued at £1,358, in 1908. The total production since 1867 is estimated at 167,354 carats, valued at £111,462.

DIAMOND INDUSTRY.

Antwerp.—The following notes on the diamond industry in Antwerp are abstracted from a report by Consul General Henry W. Diederich:[1] The trade in diamonds in Antwerp in 1910 might be considered a good average one. The exports to the United States,

[1] U. S. Daily Cons. and Trade Repts., Feb. 25, 1911.
[2] Consul General Frank D. Hill, Jewelers' Circ. Weekly, Jan. 4, 1911.
[3] Manufacturing Jeweler, Feb. 9, 1911.
[4] Min. Jour., London, Feb. 4, 1911.
[5] Rec. Geol. Survey India, vol. 40. pt. 2, 1910.
[6] Ann. Rept. Dept. Mines, New South Wales, 1909, p. 53.

the principal market, were large during the first part of the year, but fell off during the last part. The demand in the United States, formerly always for larger perfect stones, changed in part for many of smaller size and of second quality, as the price was raised by the London syndicate. The London syndicate raised the price of large stones, in which it had a monopoly, to offset the loss it suffered by the reduced price offered for smaller stones, due to the large production of such stones in German Southwest Africa. The small diamonds offered by the London syndicate were at a price 30 to 40 per cent higher than those offered by the German regie. The London syndicate advanced its price, on all stones over one-fourth of a carat in weight, from 5 to 10 per cent.

There were labor difficulties in Antwerp due to the very strict rules of syndicated workmen in allowing apprentices to learn the trade. Some of the workmen who recognized the need of increasing the number of cutters and were not allowed to teach their own sons the trade, withdrew and opened new lapidary shops in the vicinity of Antwerp and in other places in Belgium. The new enterprises found ready employment in cutting the German diamonds. The number of cutters in Antwerp rose from about 5,000 to about 12,000, who received an average wage of about $20 per week. Antwerp has led in the exportation of diamonds to the United States during the last two years. The exports from Amsterdam were nearly as large, and for many years prior to 1909 they were greater than those of Antwerp.

Amsterdam.—The diamond industry of Amsterdam has been reviewed by Consul Frank W. Mahin.[1] About 70 establishments in Amsterdam cut and polish diamonds. More than 10,000 people are employed in the trade, of whom about 1,700 are cleavers and cutters, 4,700 polishers, etc., and the remainder are engaged in other work about the offices. The workmen are divided into five classes, cleavers, polishers, turners, cutters, and sawyers. The wages range from as much as $120 per week for the best cleavers to $6 per week for sawyers. The diamond workers of Amsterdam have a close organization and admit only a few new workmen under strict examinations and instruction. A beginner must be under 18 years of age, have good eyesight, and generally has to pay well for his instruction. There are some cutters outside of the organization, and the numbers are growing.

Cullinan diamond.—The setting of the larger stones cut from the Cullinan diamond [2] in the scepter and crown of King George has been reported. The largest stone has been placed in the scepter and the next smaller one in the crown. Both stones can be removed from their mountings and worn as pendants by the Queen. The first use of these stones was at the time of the coronation of King George in Westminster Abbey in June, 1911.

Hope diamond.—The famous Hope blue diamond has changed hands several times during the last decade. It was purchased from the Hope estate by Joseph Frankels & Sons [3] and brought to the United States in 1901. Mr. Habib, of Paris, a Persian collector, purchased the gem in 1908. In June, 1909, it was advertised for sale along with other

[1] U. S. Daily Cons. and Trade Repts, Apr. 1, 1911.
[2] Manufacturing Jeweler, Dec. 15, 1910.
[3] Jewelers' Circ. Weekly, Dec. 21, 1910.

gems belonging to Mr. Habib and was reported to have been purchased by a Paris syndicate at that time. On November 23, 1910, the big blue diamond was again brought to the United States to the New York branch of the French firm of Cartier. A sale of the gem for $180,000 to Mr. Edward B. McLean, of Washington, D. C., was arranged.[1] Later suit was brought by the firm of Cartier for the fulfillment of the contract of sale, which Mr. McLean did not deem valid, since, as he maintains, he was falsely informed that the Hope diamond had never been sold for less than $250,000 previously. The suit is now in the courts.

Brazilian diamond.—According to Roderic Crandall,[2] a geologist of the Brazilian Geological Survey, a large diamond weighing 35.874 grams, or 179.37 metric carats, was sold in Rio de Janeiro in 1910. The price was equivalent to about $175,000. The diamond came from Bagagem, Minas Geraes.

Metric carat.—The number of governments that are adopting the metric carat of 200 milligrams is increasing. The law establishing the metric carat in France [3] was scheduled to take effect on January 1, 1911. An Italian law of July 7, 1910, provides that the metric carat [4] shall be used in the sale of pearls and diamonds. The use of the term carat for any other weight than 200 milligrams is prohibited. A law was scheduled to take effect in Roumania on January 1, 1911 (old style), establishing the use of the metric carat as the weight by which diamonds, fine pearls, and precious stones should be sold. Steps are being taken for the adoption of the metric carat in the Netherlands.[5] A similar law has already been proposed in Belgium. An agreement was made by jewelers and lapidists in France, Switzerland, Norway, Roumania, Bulgaria, and Spain [6] to work for the adoption of the metric carat by their respective countries as a means of simplifying trade in precious stones.

DIOPSIDE.

CALIFORNIA.

Specimens of lilac-colored pyroxene, found in the vicinity of San Francisco, were kindly furnished by Mr. J. J. Kinrade. This material has been cut for gems and ornaments under the name of pink wollastonite. The mineral occurs as fibrous and columnar radial aggregations and in seams in a dull grayish-green rock. Both purple and green minerals occur in patches of light and dark color and with them are areas of nearly pure white. The contrast of colors with the good polish to which the whole rock is susceptible is pleasing. An examination of the optical properties of the mineral by E. S. Larsen, of the United States Geological Survey, shows it to be not wollastonite, but a variety of pyroxene, probably diopside. A partial chemical analysis by George Steiger, of the Survey, also indicates the mineral to be diopside. The associated greenish minerals were only partly determined under the microscope, and consist of felted fibrous masses and stout crystals of a pyroxene, diopside or augite, actinolite, etc.

[1] Jewelers' Circ. Weekly, Mar. 15, 1911.
[2] From a lecture on Brazil before Pick and Hammer Society of the U. S. Geol. Survey, Washington, D. C.
[3] Jewelers' Circ. Weekly, Nov. 23, 1910.
[4] Manufacturing Jeweler, Sept. 22, 1910.
[5] Jewelers' Circ. Weekly, Aug. 24, 1910.
[6] Manufacturing Jeweler, Feb. 16, 1911.

ARIZONA.

Actinolite with a clear light-green to deep emerald-green color is found associated with the peridot north of Fort Defiance, Ariz. This material has been commonly mistaken for diopside and has been called chrome diopside in several reports, and was so designated in this report for 1908. The attention of the writer was called to this error by Mr. J. E. Sheridan, United States mine inspector, and tests were made proving the correctness of Mr. Sheridan's claim. Tests were also made on similarly colored mineral found with the Navajo garnet in northern Arizona and with the peridot near Rice, Ariz. These minerals were found to be diopside, however, and to contain an appreciable quantity of chromium. Mr. Sheridan has had some of the emerald green actinolite crystals cut. They yield beautiful gems, but are rather too soft for jewelry exposed to rough usage.

EMERALD.

NORTH CAROLINA.

The discovery of a new emerald prospect in North Carolina during 1909 on the land of W. B. Turner, 4¾ miles S. 30° W. of Shelby, in Cleveland County, was described in this report for that year. A few additional notes were obtained in December, 1910, and are given here with a summary of the former description. The first emeralds were found loose in the soil of a cotton field, some ten or a dozen crystals being found before any prospecting was started. Some of these emeralds were of very good color, and of fairly good quality. A few of the cabochon and drop-shaped gems cut from them have proved very pretty mounted in a necklace. A few faceted stones cut from these crystals have also been admired.

The locality is a hillside of moderate slope about 30 feet higher than the First Broad River near by. The elevation is about 680 feet above sea level. The rocks of the region 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 rocks are varied. There are mica, cyanite, garnet, and hornblende gneisses, and schists cut by granite or quartz monzonite, gabbro, diorite, amphibolite, and pegmatite. The emerald occurs in pegmatite cutting amphibolite. The amphibolite is associated with a mass of basic rock which presents two phases, oblivine gabbro and diorite. These rocks are in turn inclosed in biotite granite, and the latter rock includes masses and balls of the more basic rocks near the contact of the two. The several rocks are more or less decomposed near the emerald prospect and some phases of the decayed gabbro and amphibolite are difficult to distinguish from one another. The basic rocks make a dark, reddish-brown clay soil on thorough decomposition, and the granite gives a lighter-colored generally sandy soil. Minerals associated with the emeralds are albite, quartz—clear, colorless, and smoky—with black tourmaline, and actinolite inclusions, black tourmaline, and common green beryl crystals.

At the time of the last examination there were five openings and two small ones that had been filled up. The largest working consisted of a trench over 100 feet long and from 2 to 12 feet in depth. The next largest opening, about 7 feet east of the trench, was a pit

15 feet long, 9 feet deep, and 7 feet wide. All of the workings were within a space of 50 feet and were in an east and west direction from one another. Decomposed and partly chloritized amphibolite and gabbro were encountered in each cut. In the largest trench four or five pegmatites were cut, most of them being small. Emeralds were found in one pegmatite only, the other pegmatites containing only quartz and tourmaline crystals. Veinlets of quartz crystals, with little if any other mineral, cut the amphibolite. Some of the quartz crystals from these veinlets are very clear and measure 2 inches through. Part are colorless and part smoky brown. The pegmatite carrying the emeralds is lens-shaped with irregularities in direction. In the larger pit it was 30 inches wide at the surface on the east side of the pit and 18 inches wide on the west side. At a depth of 10 feet the pegmatite was about 18 inches wide. An offset or overlapping lens of pegmatite was exposed in the east face of the pit near the surface. The pegmatite has an irregular strike approximating east and west and a dip of 80° N.

The gem-bearing pegmatite is medium to coarse grained and is composed of quartz and feldspar, part of which, at least, is albite, with some black tourmaline sprinkled through it and an occasional emerald or green beryl crystal. The crystallization of the minerals of the pegmatite is not good, but a few partly developed crystals are found in small irregular miarolitic cavities. Crystals found in these cavities are colorless and smoky quartz, albite feldspar, black tourmaline, and a little beryl. The cavities in the pegmatite are partly filled with reddish brown, greasy feeling clay, and the same material along with limonite stains has permeated joints and seams through the pegmatite. The feldspar of the pegmatite has partly decomposed in places, so that the rock breaks down rather easily. Some of the emerald crystals are firmly attached to other minerals and others are loose and may be obtained by washing the semidecomposed pegmatite. Many small fragments and crystals of emeralds have been found this way, but up to 1911 only a very few pieces of gem emerald had been found in place in the rock, nearly all the gem material having come from the surface.

Mr. George L. English, who has assisted Mr. Turner in prospecting for the emeralds, has kindly given the following information [1] on the latest developments at the mine. The main pit has been sunk to a depth of 15 feet on the pegmatite and another pit a few feet to the east has also exposed the "vein." In this pit the pegmatite was about 5 feet wide and had a dip of 15° to 20° E. A trench about 10 feet deep and nearly 30 feet east of the main pit has also cut the "vein." Several other prospects on the place have shown the presence of pegmatite but failed to develop emeralds. At one of these prospects, an eighth of a mile southwest of the main locality, an abundance of fine black tourmaline crystals, a little dark green apatite, two unidentified minerals—one a metallic mineral and the other a dark resinous one—and a blue mineral resembling crocidolite were found.

In the main pit a large pocket of emerald crystals was found at a depth of about 10 feet. Most of these were pale in color, but some were nearly equal to the pieces found on the surface. Only a few

[1] Personal letter dated Shelby, N. C., June 2, 1911.

small pieces have been cut, and a faceted stone among these was sold at the rate of $48 per carat. The largest crystal found measured 2¼ inches long by five-eighths of an inch in diameter, and weighed 26.2 grams. This crystal was broken into four pieces. The color, except near the termination, is pale and the crystal is deeply striated so that its color does not appear so strong as on broken surfaces. Many of the crystals from this part of the "vein" are opaque inside, but have their transparent shells of rich green color that would cut into good faceted stones of small size.

SOUTH AMERICA.

Notes on the rediscovery of certain lost emerald mines in Colombia have been given by E. B. Latham.[1] Emeralds were highly prized by the Indians of South America and were mined by them for centuries prior to the coming of the Spanards in three districts of the present Republic of Colombia. These districts, Muzo, Cosquez, and Somondoco, were widely separated. When the Spanish took possession of the country about 1555, the emerald mines also were taken up. Excessive cruelties were practiced by the Spanish mine workers on the Indians employed in the mines. The trouble was not averted by the importation of African negroes, and in the war of independence of 1816 following, the country was so desolated that the mines of Cosquez and Somondoco were entirely lost. From that time until recently the Colombian emeralds have been obtained only from Muzo.

A Colombian named Francisco Restrepo, guided by a few hints given in ancient Spanish parchment maps, and with little or no knowledge of geology or emeralds, undertook the search for the lost emerald mines. In 1896 he found traces of ancient workings and later the large workings of the lost mines. The mines are situated on a sectional ridge of the great eastern range of the Andes Mountains, at an elevation of about 9,000 feet above sea level. An old ditch 12 to 15 miles long, with reservoirs above the mines, was found. The great open cuts and tunnels were scattered over an area 6 miles long east and west and 3 miles wide north and south. Some of the working faces of these mines measure 700 to 300 meters on steep slopes; of this about 100 meters is emerald-bearing and the rest nonproductive. The emerald region is covered by forest and jungle, which doubtless conceal other workings in the region. The climate is about that of perpetual late autumn.

AUSTRALIA.

New South Wales.—The emerald mine at the Glen in the Emmaville Division, New South Wales,[2] was reopened during 1908. About 1,000 carats of emeralds, valued at over £1,600 were obtained. The largest stone weighed 60 carats in the rough. The largest stone obtained in a parcel of cut emeralds weighed 6 carats. Some of the emeralds are of good quality, but the majority are pale colored.

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[1] School of Mines Quart., vol. 32, 1911, pp. 210–214.
[2] Ann. Rept. Dept. Mines New South Wales, 1909, p. 54.

GARNET.

NORTH CAROLINA.

Garnet crystals for abrasive purposes and occasional gems have been obtained from a deposit 8 miles in a southeasterly direction from Morganton, along Laurel Creek, Burke County, N. C. They are a calcium free, iron magnesium garnet belonging to the pyrope type. The color is a deep pink to rich wine red, and some good gems, especially for carbuncle cuts, have been obtained from them. These garnets occur in slightly graphitic schist, which is both micaceous and cyanitic in places, and is a member of the Carolina gneiss. They are closely associated with a pyroxenite rock and occur in the schist at or near the contact with this rock. The pyroxenite occurs in lenticular and rounded masses of various sizes in the schists. These masses range from less than a foot across up to many yards in thickness. In many cases the pyroxenite has altered to chloritic soapstone to a depth of several feet from the surface. There has been contact action between the pyroxenite and inclosing schists, as shown by the presence of chlorite zones between them.

The garnets occur scattered through or in streaks in the schist, either at the contact with the pyroxenite or at a distance of several feet from it. The garnets range in size from a fraction of an inch to 3 or 4 or more inches in diameter. Many of them, especially of those near the surface, have been badly decomposed, and in some cases entirely so, and have passed into reddish-brown earthy masses. The garnet occurs in the bedding of the schist which they have forced apart, so that it assumes an augen shape around the crystals. This augen effect is very striking in some cases where small masses of kaolinized feldspar occur in the augen on each side of the garnet.

Rhodolite is the name given by Hidden and Pratt [1] to the rose pink garnet found in Macon County, N. C. Attention was called to this garnet in 1893 by A. M. Field, of Asheville.[2] For several years it was supposed to be a variety of almandine, until analysis showed that its composition is equivalent to two molecules of pyrope and one of almandine. It was accordingly given the varietal name rhodolite by the analysts, from the Greek words equivalent to rose stone. Rhodolite ranges in color from pale rose pink to dark rose pink, and some of the gems have a purplish cast. As the clear rhodolite garnets are exceptionally free from inclusions, they are very brilliant and display their color well. Large garnets are not plentiful, though stones weighing as much as 14 carats [3] have been cut. Dr. Kunz estimates that about $53,000 worth of these garnets have been sold.

The principal locality from which rhodolite garnets have been obtained is in the valley of Mason Branch, about 5 miles north of Franklin. The gem has also been found associated with ruby in Cowee Valley, and occasionally stones of a size sufficient for cutting have been obtained when mining for ruby. Pink and purplish garnets, some with practically the same color as rhodolite, though generally of a dark shade, have been found in other parts of Macon and Jackson counties. It is sometimes difficult to distinguish between

[1] Hidden, W. E., and Pratt, J. H., Rhodolite, a new variety of garnet: Am. Jour. Sci., 4th ser., vol. 5, 1898, pp. 294–296.

[2] Kunz, G. F., History of the gems found in North Carolina: Bull. North Carolina Geol. and Econ. Survey No. 12, 1907, p. 50.

[3] Op. cit., p. 51.

the dark-colored rhodolite and the light-colored almandine with a pink or violet color.

The rhodolite garnet deposits in the valley of Mason Branch were worked from 1893 to 1901, inclusive. Most of the gem garnets were obtained from the gravel deposits along the branch where both sluicing and hydraulic mining were carried on. A dam was constructed across the branch to secure water for these operations. Many of the garnets from the placer deposits consisted of nearly pure gem material, the fractured portions of the originally larger garnets having been removed by attrition in the stream gravels, leaving only hard pebbles and fragments of solid garnet. As associated minerals Hidden and Pratt[1] mention—

> quartz, rarely as isometric pseudomorphous dodecahedrons; small rough garnets of a dark pyrope nature; small corundum crystals of pale blue, amethystine, and pink shades, sometimes with a distinct ruby tendency; spinel, the pleonaste and gahnite varieties; bronzite, transparent; iolite, colorless; cyanite; fibrolite; hornblende; staurolite (often clear and glassy); rutile; menaccanite; chromite (rare); monazite (rarely green); zircon; gold and sperrylite in minute quantities

Some of these minerals are more completely described in a later publication.[2]

The better portions of the placer deposits were worked out in 1901 by the American Gem Mining Syndicate. During the operations of this company prospecting was carried on for rhodolite in the matrix in the surrounding region. Some measure of success was met with in the prospects on the north side of the valley of Mason Branch, especially near the summit of a knob where three openings were made. The rhodolite here occurs disseminated through mica schist or gneiss in crystals ranging from a small fraction of an inch to over 3 inches in diameter. The crystals are inclosed in biotite, quartz, and other minerals of the rock. The rhodolite replaces irregular masses of biotite and occurs in lenticular wrappings of biotite flakes. Small flakes of biotite and grains of quartz are inclosed in some of the garnet crystals. The majority of the rhodolite crystals are more or less fractured and some have well developed parting planes that divide the crystals into small grains. However, gems of fair size have been obtained from the rock matrix.

In one of the openings a hard ledge of rhodolite garnet gneiss 3 feet thick was encountered. The rock on either side of this ledge was partly decomposed and soft. Garnets of a beautiful pink color were observed in this ledge and of such a size as to indicate the probable presence of gem material. In a thin section cut from a specimen from this ledge much bronzite associated with the garnet was observed under the microscope. The section contained also quartz, biotite, pyrite, apatite, rutile, zircon, and probably ilmenite.

JADE.

BURMA.

The exports of jade (jadeite) from Burma through Rangoon in 1909 amounted to 4,088 hundredweight,[3] valued at £84,450, as compared with 3,211 hundredweight, valued at £73,400, in 1908. The

[1] Hidden, W. C., and Pratt, J. H., Rhodolite, a new variety of garnet: Am. Jour. Sci., 4th ser., vol. 5 1898, p. 294.
[2] Am. Jour. Sci., 4th ser., vol. 6, 1898, pp. 463–468.
[3] Rec. Geol. Survey India, vol. 40, pt. 2, 1910.

production reported from the Myitkyina district, where the jadeite mines are situated, amounted to only 2,487 hundredweight, valued at £14,892—though these figures may not be reliable.

JASPER.

CALIFORNIA.

A red jasper-like quartz with a spherulitic texture, found in the San Francisco region, has been used locally for gems and ornaments. This material is cut by Mr. J. J. Kinrade, of San Francisco, by whom it was discovered about 30 years ago, and who kindly supplied a specimen for examination. Mr. W. T. Schaller, of the United States Geological Survey, generously furnished other specimens, with microscopic sections and general information on the occurrence and nature of the rock. Mr. Schaller states that this spherulitic quartz is found about 1 mile south of Sausalito, in Marin County, and near Lands End station, San Francisco County, about 1 mile northeast of the Cliff House. At the latter locality the spherulitic rock is found in irregular masses in a greatly altered basic rock, probably diabase, which, with sandstone and serpentine, forms a portion of the Franciscan formation.

Near Sausalito the rocks also belong to the Franciscan formation, and consist of sandstone and radiolarian chert with intrusive basalt and diabase which may be portions of the same intrusion. The spherulitic quartz is found at the water's edge where the principal formations are radiolarian chert, basalt, and diabase. A thin layer of sandstone is included between the chert and the igneous rocks at this point. Lenticular inclusions of radiolarian chert and spherulitic quartz, surrounded by layers of, and inclosing, greenish material, occur in the basalt and diabase. Many of these inclusions have been washed out by wave action and deposited as pebbles and cobbles along the shore.

The spherulitic rock occurs with a variety of markings and colorings due to variations in texture and composition. In some specimens the bulk of the rock consists of red spherulites in a matrix of red, brown, and green. In other specimens the matrix predominates and contains spherulites scattered irregularly through it. The spherulites range from almost microscopic dimensions to over an inch in diameter. Most of them measure only a fraction of an inch across. Practically all of the spherulites visible to the naked eye are either dark or light red, but some of the green mineral possesses a spherulitic texture visible under the microscope. The spherulites have a radial structure with concentric bandings around the center. The centers more commonly are bright red and are surrounded by one or more layers of lighter red. The outer portion of the spherulites is less strongly colored and exhibits the fibrous radial texture plainly. Green, brown, gray, and black fragments and streaks compose the remainder of the rock. The whole has been fractured and cemented together again, even the spherulites, many of which show stars, with three to seven or more rays filled with lighter-colored mineral, in their centers. Pebbles and fragments of jasper-like red quartz similar to the spherulite rock, but without such striking texture, are found with the spherulitic rock. They contain similar associated green mineral and country rock. The rock con-

sists largely of silica, but some specimens contain considerable iron present as hematite. An analysis of material from the vicinity of Lands End, by Mr. Schaller, gave 88.5 per cent SiO_2 and 10.3 per cent Fe_2O_3. This rock contains much free hematite filling interspaces between spherulites, besides that occurring as microscopic dust throughout the spherulites and other minerals. Such great quantities of free hematite were not observed in the specimens from near Sausalito, and it is probable that analysis would show a much smaller per cent of Fe_2O_3.

In thin section under the microscope the spherulites present all the appearances of chalcedony but, unlike that mineral, have a positive elongation characteristic of quartz. They are composed of radiated fibers, and between crossed nicols give a dark cross extinction which reacts positively when tested with the gypsum plate. The pigment of the spherulites is seen to be a red dust, apparently hematite, generally arranged in layers with concentric structure. The starlike fractures in the spherulites resemble shrinkage cracks and are filled with fibrous to granular quartz which incloses practically no hematite. The quartz stars are in many cases connected with seams of quartz ramifying through the rock.

In other portions of the rock quartz occurs in irregular-shaped masses, inclosing variable quantities of hematite dust. In places the hematite is segregated into clusters of particles and nearly solid masses in the quartz. Grains of pure hematite over a millimeter across compose a portion of the matrix in some specimens and are especially abundant in the material near Lands End.

The green portion of the spherulitic rock is difficult to determine and is composed of more than one mineral. Much of it is an olive to yellowish green, resembling epidote. Some of the material consists of altered basalt fragments, and other is a nearly amorphous substance with a spherulitic radiated texture locally developed. A part has the texture of chlorastrolite, but has not been identified as that mineral.

The jasper-like spherulitic rock polishes well and is very handsome. The variety of patterns and colors and the extreme beauty of the spherulites when examined closely render the stone attractive. It would serve well for small ornamental objects, as inkstands and paper weights, and some is quite pretty enough for use in jewelry. It could be used in the same way as jasper and strongly colored agates.

Mr. Kinrade reports the occurrence of red spherulitic quartz at numerous places along the coast of California from San Francisco to the Oregon line. A specimen cut from material found near Point Bonita, on Marin peninsula, contains red quartz spherulites in ocher-yellow jasper or quartz matrix. The combination is pleasing.

The trade name "kinradite" has been proposed for the spherulitic quartz by several gentlemen interested in an amateur way in native gems, and in the part Mr. Kinrade has taken to show the possibilities of such material in the San Francisco region. This proposition comes from Harry C. Catlin, John C. Catlin, Thomas R. Craigie, and Alfred Galpin, of San Francisco. The selection of the name "kinradite," in acknowledgement of Mr. Kinrade's services in exploiting a gem of interest to both the local and the tourist trade of California, is very appropriate.

Mr. A. H. Alverson, of San Bernardino, kindly furnished specimens and information concerning a newspaper report on the discovery of bloodstone in Death Valley. Most of the material might be best called red and green jasper, but a few pieces might be called bloodstone. The material came from a locality near Canyon Springs, about 100 miles east of San Bernardino, that has been known for years. The jasper occurs in a vein and in nodular masses. The nodules have red cores and dark green shells and range in size up to 4 or 5 inches in diameter. Specimens examined were about an inch and a half across, and one of them contained a few red patches and streaks in the green. The nodules furnish handsome specimens when polished. No work has been done on the deposit, but years ago considerable surface material was gathered up and sold in San Francisco.

Mr. Young J. Gilbert, of San Bernardino, Cal., mentions the occurrence near Barstow of agate-like jasper, in which are streaks of opal, some being fire opal. Good gem specimens of both minerals have been obtained from the deposit. The property formerly belonged to the California Gem Co., but the assessment work is now kept up by Mr. Gilbert.

MASSACHUSETTS

Mr. Shelley W. Denton, of Wellesley, Mass., reports the finding of a small quantity of red and green jasper in the town of Rowley, Mass. Some of this has been cut "en cabochon" for arts and crafts jewelry with good effect.

LAPIS LAZULI.

CALIFORNIA.

Mr. R. M. Wilke, of Palo Alto, Cal., reports the discovery of lapis lazuli in San Bernardino County, Cal., during 1910. The mineral was found as float and has not been discovered in place as yet, but it is hoped this will be accomplished by further prospecting. Some of the specimens of lapis lazuli were associated with gray limestone, indicating the rock in which the gem may be looked for.

OPAL.

IDAHO.

The occurrence of opal in the northern end of the Owyhee Range, Owyhee County, Idaho, has been briefly described by Lindgren, Drake, and Schrader.[1] Deposits have been opened on Squaw Creek and along the Caldwell-Rockville road about 2 miles east of south of Sommer camp. Some good fire opals have been found, and at one time there was considerable excitement over the gem. Three of the deposits were visited in June, 1910, but no work was in progress at any of them.

The deposit in the valley of Squaw Creek below the junction with Little Squaw Creek is situated in a small rounded hill about 1 mile above the ranch of Jim Keith. The elevation is about 3,500 feet above sea level and that of the mountains around about 1,000 feet higher. The country is treeless and the low hills in the valley are

[1] Silver City folio (No. 104), Geol. Atlas U. S., U. S. Geol. Survey, 1904.

covered only with sagebrush and a small quantity of grass. A few small pits have been made on the summit of the hill and on the south side, cutting into the partially disintegrated basalt in which the opals occur. The basalt is highly vesicular and under the microscope is found to be composed chiefly of lath-shaped crystals of labradorite, augite, and a brownish glass. The basalt is a portion of a flow which partly fills the canyon of Squaw Creek and rests on rhyolite and rhyolite tuff, the most important formation of the region. The partially disintegrated basalt breaks up fairly easily and is removed from the pits in large blocks. These blocks are broken up and the opal picked out. The opal occurs as amygdaloid in the steam holes and cavities in the basalt. The greater part of the cavities contain no opal, and only a part of the opal is of the precious variety, much of it being milky white or colorless. In some of the blocks of basalt broken into the opal is plentiful, and much of it has a fine play of colors. Most of the opal is in small pieces and large specimens of precious opal are rare. Some of the vesicles are filled with chalcedony or chalcedony and opal. Fragments of chalcedony and chalcedony with white opal 2 inches across were observed loose in the soil on the hill. Some of this material is banded both with curved bands and straight onyx bands. Similar specimens of chalcedony and white opal were seen in other places in the valley.

One of the larger opal mines, 3 miles west of Enterprise, contained two sets of workings on different sides of a draw or valley. They are from 35 to 65 feet above the bottom of the draw. The principal workings are on the west side, and consist of several open cuts, the largest about 50 feet long and 25 feet deep, and a tunnel 40 feet long. The other openings are about 150 yards to the northeast diagonally across the draw, and consist of open cuts.

The opal deposits are in whitish chalklike decomposed rhyolite, in which occur inclusions of blocks and rounded masses of gray to brown, glassy, perlitic rhyolite. The perlitic rhyolite appears to be the same as the inclosing decomposed rhyolite, but has not undergone alteration. A weathered yellowish fine porphyry bed occurs over the opal-bearing rhyolite outcropping as a hard stratum. The formations have a gentle northerly dip and the rhyolite can be recognized at numerous places by its light-colored outcrop. The opal occurs in seams and veinlets, filling cracks and joints, as a filling in a brecciated fracture zone, and in nodular masses, both in the altered rhyolite and in the perlite. White and milky opal was plentiful around the dumps and a few small chips of precious opal were seen. Judging from the extent of the work done, it is probable that valuable opal was found.

At another deposit, about 2 miles east of south of Sommer camp and 4 miles west of Enterprise, about half a dozen pits have been made within 200 yards of one another, which range in size from 4 to 20 feet in depth and about the same in width. They are in a bed of partly decomposed whitish rhyolite, interbedded with brownish glassy rhyolite. The formations are gently folded and the rhyolite outcrops at several places to the south along the road on the hill above. The beds have an aggregate north dip. Other prospects were opened on some of the upper outcrops of the rhyolite. Considerable chalcedony and white, milky, and bluish opal were seen on the dumps around the pits. White opal and translucent gray chalcedony are

banded together in some specimens like onyx. Very little precious opal was seen around the old workings.

WASHINGTON.

Among localities in Washington where opal has been mined is that on the land of George Odonnell, about 5 miles northwest of Moscow, Idaho. This was known as the Leisure place when worked for opal by Hall & Vennigerholz in 1891 and by Hall & Sons in 1892. The country is rolling meadowland, with but few rock outcrops, well adapted to the growing of wheat, and little attention is paid to the possibilities of gem mining. George F. Kunz [1] states that opal was found at this locality in August, 1890, during the digging of a well. The yield from this locality in 1891 was estimated at over $5,000, and J. G. Vennigerholz states that $5,762 worth were sold.

Mining was carried on at three places situated about 200 yards apart in a triangular space, and Mr. Odonnell's house now stands near the middle. At one of the places, over 100 yards north of the house, nearly an acre of ground had been worked over by pits ranging from a few feet to 20 feet in depth. Southeast of the house a cut 100 feet long and 20 feet wide was made along a branch. Other pits were made southwest of the house. The greatest difference in elevation at the different workings is about 20 feet. The dumps contain piles of vesicular basalt broken into blocks a few inches thick. The basalt is evidently a part of a flow covering large areas in this region. Some of the basalt is partly weathered and has a gray color. The fresh rock is grayish black and hard. The principal minerals determined under the microscope were labradorite feldspar, brown augite, and iron ores with a brownish glass. In places hyaline opal occurs, filling the vesicles and seams in the rock. Occasional patches of precious opal may be found by breaking considerable rock. In places precious opal was found thickly scattered through the basalt. Some very fine gem opal was obtained at this locality.

AUSTRALIA.

New South Wales.—The value of precious opal produced in New South Wales [2] in 1909 amounted to £61,800, as compared with £41,800 in 1908. This was an increase of £20,000, but the production was less than that of 1907 by £17,200. The production of the White Cliffs Division declined from £31,800 in 1908 to £21,800 in 1909 and that of the Walgett Division rose from £10,000 in 1908 to £40,000 in 1909. The beautiful "black opal" from the Walgett Division has realized higher prices than the lighter-colored material. Black opal is, however, scarce.

Queensland.—The production of opal in Queensland,[3] in 1909, was estimated at £2,000, as compared with £2,500 in 1908.

QUARTZ.

PENNSYLVANIA.

Louis J. Deacon, of Atlantic City, N. J., reports the discovery of a limited quantity of quartz crystals 1¼ miles northwest of Stroudsburg, Munroe County, Pa. The crystals were found in a field on

[1] Mineral Resources U. S. for 1892, U. S. Geol. Survey, 1893, p. 776.
[2] Ann. Rept. Dept. Mines New South Wales, 1909, p. 54.
[3] Ann. Rept. Under Secretary of Mines Queensland, 1909.

the Cherry Valley side of Godfreys Ridge. They are mostly clear and colorless and range in size from one-eighth of an inch to 3 or 4 inches in length and from one-eighth of an inch to 1½ inches in diameter. Some are very similar to the quartz crystals from near Little Falls, N. Y., called "Herkimer County diamonds." They occur principally in single crystals, but groups of crystals have been found. No crystals have been found in place. On cutting, several of the quartz crystals proved quite equal to similar stones from other localities.

OREGON.

Prof. G. Montague Butler, of the Colorado School of Mines, reports the collecting of dull-green prase and prase opal by Arthur Rudd, of Joseph, Oreg., on the lower Inmaha River. The material was not placed on the market, but should make a good gem for arts and crafts jewelry.

ROSE QUARTZ.

CALIFORNIA

Specimens of rose quartz from California were kindly supplied by Messrs. W. D. and George W. Parson. This quartz comes from Tulare County, near the Kern County line, on the east side of the first high western range of the Sierra Nevada Mountains. The specimens range in color from nearly colorless to very delicate pale pink to deep pink. All of the quartz is partly opalescent or milky, though the lighter-colored varieties are nearly clear. The several varieties would serve for gem purposes as beads and cabochon cut stones. Flawless specimens the size of a pecan nut are found, and some pieces of large size with small seams or feathers can be obtained. The more or less perfect fragments up to an inch through are obtained by breaking up larger blocks of the rose quartz, from which they fall out as the fracture or rift planes are exposed.

RUTILATED QUARTZ.

NORTH CAROLINA.

Rutilated quartz has been found on the plantation of David Fortenberry, 2 miles west of Casar, Cleveland County, N. C. The specimens were gathered from the surface of plowed fields. Some of the rutilated quartz is of very good quality, the quartz being clear and colorless and penetrated by abundant small red needles of rutile. Both specimens and gem material have been obtained. The country rock at this locality is biotite gneiss and schist containing porphyritic feldspar crystals and intruded by granite dikes. The occurrence of the rutilated quartz in the rock has not been exposed, as no development work has been done. The cultivation of the land followed by rains serves to unearth and expose the mineral on the surface.

RHODONITE.

CALIFORNIA.

Wheeler rhodonite prospect.—Some beautiful rhodonite has been obtained from a deposit about 9 miles north of Happy Camp, Siskiyou County, Cal. The original work was done for gold by Jack Ince, of

Happy Camp, and consisted of a small pit. The prospect was located in October, 1907, by Cyrus Wheeler and Charles Gilmore. Mr. Gilmore's interest was later taken up by Mrs. E. M. Wheeler. Some of the mineral has been cut by the Southwest Turquoise Co., of Los Angeles. The deposit is on a steep slope on the east side of Thompson Mountain, between the east fork of Indian Creek and Thompson Creek. It is about 4 miles northeast of the forks of Indian Creek or 6 miles in the same direction from the Collier and Smith jade (californite) mine. The elevation is about 4,500 feet above sea level, or 3,500 feet higher than the forks of Indian Creek. A placer claim has also been located on a good spring a quarter of a mile south of the prospect and nearly 400 feet lower. The mountain slopes below the prospect are heavily timbered with spruce and pine, some of which are over 8 feet in diameter. The mountain side at the prospect is covered with tough manzanita brush with a few small scattered trees.

A pit was made above the outcrop of the rhodonite and an open cut below with a tunnel 27 feet long running under it. As exposed by the workings, the rhodonite is in the form of a ledge 6 feet thick, with a northwest strike and dip of about 20° NE. back into the hillside. It was not possible to determine from the limited amount of work whether the rhodonite consisted of a regular bed or whether it was only a lens included in the rock formations. The dip of the ledge should bring it into the tunnel, and its failure there may be accounted for by a fault or pinching out of the deposit. Several small faults were observed in the open cut. It is said at the outcrop that the ledge was small, but became larger within a very few feet.

The country rock in which the rhodonite occurs appears to be a fine-grained quartzite with interbedded black schist. On the hill above is a fine granitoid dioritic rock with soapstone on the summit of the mountain a hundred yards northwest of the rhodonite outcrop. Associated with the rhodonite is considerable black oxide of manganese, both in masses and filling seams and joints through it. Seams of manganese oxide also occur in the quartzite which has a texture similar to the rhodonite and in places has a slight pinkish tint. The material called rhodonite when examined in thin section under the microscope is seen to consist of a mosaic of rhodonite and quartz grains. These facts indicate that the rhodonite may be a replacement of a bed or a portion of a bed of the quartzitelike rock.

The rhodonite used for gem and ornamental purposes has a delicate pale to dark rose-pink color, with an even texture. The pure pink material alone furnishes pretty gems, but probably equally good are those which contain some of the black oxide of manganese and other matrix. Large pieces of pure pink rock are not plentiful, but most of the rhodonite contains greenish-gray inclusions or matrix of altered quartzite. Specimens which contain the three colors often furnish pleasing contrasts for gems. The manganese oxide seams appear as lines and patches in the pink and greenish-gray gems and add to their beauty by the strong contrast. Some rich pink to nearly coral red granular rhodonite is obtained that yields pure gems of several carats weight.

MONTANA.

A specimen of rhodonite from Butte, Mont., was received from the Western Gem Co., of Los Angeles, by which company a quantity of the material has been cut. The specimen consists of granular rho-

donite with a delicate rose-pink color, in which are patches of gray quartz, black oxide of manganese, and a few small grains of pyrite. Under the microscope the specimen is seen to consist of elongated rhombic and columnar crystals of rhodonite arranged in radiating groups with quartz, a little pyrite, and dark-brown oxide of manganese stains. Rhodonite from Butte has been used for gems for many years. Such material from the Alice mine, associated with rhodochrosite, was mentioned by George F. Kunz [1] in 1884.

RUBY, SAPPHIRE, AND SPINEL.

INDIA.

The production of ruby, sapphire, and spinel in India in 1909 came from the ruby mines of Mogok, Burma,[2] and amounted to 258,304 carats, valued at £58,649, as compared with 281,014 carats, valued at £83,505, in 1908. The production in 1909 amounted to 205,384 carats of rubies, 13,457 carats of sapphires, and 39,463 carats of spinel. The sapphire deposits of Upper Kashmir, which were worked from 1906 to 1908, were not operated in 1909.

SAPPHIRE.

MONTANA.

Sapphires have been mined at several localities in Montana, both from placer deposits and from the rock matrix. The best known placer deposits are those along Missouri River, east and north of Helena, along Dry Cottonwood Creek, Deerlodge County, and on the waters of Rock Creek, Granite County. Sapphires in rock matrix are mined in the Judith River region, Fergus County. The greater number of the sapphires from this locality have a (sapphire) blue color and are of gem quality, but those from the placer deposits are varicolored and only a small proportion of them can be used for gems. The colors most commonly seen are yellow, yellowish green, bluish green, and greenish blue. Occasionally dark-blue, straw-yellow, topaz-yellow, and light and dark rose-pink stones are found.

Missouri River sapphires.—According to George F. Kunz,[3] the earliest mention of the finding of sapphires in Montana dates back to May 5, 1865, when they were found by a prospector named Ed Collins. Mr. Collins sent specimens to New York and to Amsterdam in search of a market.

Sapphires have been found with gold in the placers along Missouri River from Canyon Ferry, about 15 miles north of east of Helena, for a distance of about 20 miles down the river to a point about 15 miles east of north of Helena. With the exception of a small amount of placer mining at intervals by individuals, no mining has been carried on for several years.

Sapphires were obtained, previous to 1891, as a by-product in gold mining, and no systematic mining for them was attempted, as the demand was limited. Active mining for sapphires commenced in 1891, after a large English company had obtained control of several of the most important deposits. Miles of ditches and flumes were con-

[1] Mineral Resources U. S. for 1883–84, U. S. Geol. Survey, 1885, p. 767.
[2] Rec. Geol. Survey India, vol. 40, pt. 2, 1910.
[3] Mineral Resources U. S. for 1893, U. S. Geol. Survey, 1894, p. 692.

structed and water brought to the deposits for sluicing and hydraulicking. Smaller companies were also formed to mine for sapphires. The English company was reorganized as an American company in 1897, but little work was done after that time. There has been litigation over the properties and valuable flumes and siphons have been allowed to fall to pieces. Much of the property is now owned by A. N. Spratt, of Helena.

A brief visit was made to several of the deposits in June, 1910. No mining was in progress at the time, so that no opportunity was afforded to examine concentrates, and at one mine only was a guide available to point out subjects of interest. J. H. Pratt [1] mentions a number of deposits and shows the approximate location of several of them along Missouri River. George F. Kunz [2] has described some of these deposits and mentioned a number of others. Through the kindness of Mr. A. N. Spratt the writer was enabled to visit the following mines: Eldorado Bar, 9 to 12 miles below Canyon Ferry, and Gruell Bar, 4 miles below Canyon Ferry, on the northeast side of the river, and French Bar, 2 miles below Canyon Ferry, and Spokane Bar, 5 miles below Canyon Ferry, on the southwest side of the river. Among other deposits are Emerald Bar, near Canyon Ferry; Dana Bar, near the mouth of Prickly Pear Creek, across the river from Eldorado Bar; and American Bar, about 6 miles below the mouth of Prickly Pear Creek, on the east side of the river. Among other placers Pratt mentions Magpie Gulch and Cheyenne Bar, near Canyon Ferry, and Metropolitan Bar, across the river from Spokane Bar. Ruby Bar, mentioned by Kunz, is about 6 miles below Eldorado Bar. Pratt states that no sapphires have been found along the river above Emerald Bar, near Canyon Ferry, and that no large quantities have been found below American Bar.

Missouri River flows northwest, with an irregular course in the sapphire region. The elevation of the river is about 3,500 to 3,600 feet above sea level. The flow of water is large and crossings must generally be made by bridge or by ferry. Dams, with electric-power plants, have been erected at Canyon Ferry and below Eldorado Bar. The country along the river in the sapphire region consists of a few bottom lands, terraces, prairies, hills, and mountains. The present period of erosion by the river has not been greatly disturbed at any time, so that no extensive river flats have developed. The terraces, representing former levels of erosion are, in places, over a mile wide and rise with gentle slopes from their edges at the bluffs near the river to the foot of the hills on the farther side. Some of the terraces pass into the prairies, especially between Prickly Pear Creek and Spokane Creek. Draws and small gulches without water cross the terraces at intervals. A few miles from the river the mountains rise to elevations of 5,000 to 7,000 feet above sea level. The country along the river is mostly bare of forest, but pine timber suitable for lumber grows on the mountains to the northeast. The terraces are covered with prairie grass, with a few scattered pine trees growing along the river banks and in the draws. Several creeks entering the river in the sapphire region, as Soup Creek, Trout Creek, and Spokane Creek, are available for mining purposes. Water for hydraulicking might also be pumped from the river to the terraces, and for this purpose

[1] Corundum in the United States: Bull. U. S. Geol. Survey No. 269, 1906, pp. 106–110 and map, Pl. VI.
[2] Mineral Resources U. S. for 1891, U. S. Geol. Survey, pp. 542–544; 1892, pp. 760–762; 1896, pp. 1199–1200.

the presence of several electric power-transmission lines in the country would prove convenient.

The rocks of the sapphire region are chiefly slates, limestones, and quartzites, with syenite or monzonite and other intrusive rocks. The age of the sedimentary formations has not been determined, but it is probable that they are Carboniferous or older. Limestone and quartzite are largely developed in the mountains northeast of the river and are there strongly folded. Dark gray, red, purple, and green slates have been exposed under the majority of the placer workings. A mass of dark-gray coarse-grained syenite or monzonite outcrops at Canyon Ferry, and a similar rock, probably more nearly diorite, outcrops on Trout Creek above York. Kunz[1] says:

> At Ruby Bar the sapphires were observed in a vein of eruptive rock 6 feet wide, cutting green slate. The rock is very much altered, and in it were found, associated with the sapphires, ruby red pyrope garnets and sanidine feldspars. * * * Mr. H. Miers, of the Natural History Museum, London, reports that the rock is a vesicular mica-augite andesite.

Pratt[2] mentions a dike at French Bar 3 to 6 feet wide, that contained greenish sapphires. This dike cut through slate and is probably of the same character as the one described by Kunz.

The sapphire-bearing gravel beds are in the terraces and are called "bars." The principal bars lie at elevations of from 100 feet to nearly 200 feet above the river. At some places there are smaller beds at lower levels and on the slopes from the main bars extending down to the river. The bars that have been most worked for gold and sapphires are over 100 feet above the river. The gravels range in size from a few feet to over 40 feet in thickness in some of the bars and have been washed to depths of 30 feet in places. The gravels are variable in size, and contain sand and pebbles with bowlders over 2 feet thick. The rocks represented are those of the adjoining region with several other types not observed in a brief examination of the region.

Eldorado Bar is about 3 miles long in an east and west direction and from a few hundred yards at the ends to over a mile in width near the middle. The eastern end is near Soup Creek and the western end at the place where the river valley narrows down above the mouth of Prickly Pear Creek. The edge of the bar at the middle near the river is about 150 feet above the water. The bar is from 50 to 100 feet higher at the side along the hills. There is a bench with gravels between the main bar and the river as much as 200 yards wide in places and nearly 75 feet above the water. The main bar contains over 1,000 acres of prairie land, of which only a small part has been mined. Three draws or gulches cross the bar, and mining operations were along these or close to the edge of the terrace. Other prospect pits and shafts were made in testing the gravels. From east to west the three gulches are Tunnel Gulch, Williams Gulch, and Cedar Gulch. They vary from nearly 100 feet deep near the river to a few feet deep back on the bar, and furnish convenient channels for the removal of débris in mining. The gravels have been hydraulicked to depths of more than 20 feet in places. In large areas mined they were 10 to 15 feet thick.

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[1] Mineralog. Mag., vol. 9, 1891, p. 396.
[2] Op. cit., p. 107.

The bedrock exposed in the workings is red, green, and black slate, but a portion of the western end of the deposits may cover limestone and quartzite. These rocks outcrop in the hills on the north and west of the bar in the form of hogbacks. The gravels are composed of much rounded bowlders, cobbles, and pebbles of quartzite, limestone, conglomerate, slate, gabbro, fine-grained trap, granite, and some quartz, chalcedony or agate, etc., with sand. In mining the larger bowlders were left stacked over the placers and all finer débris was washed into the gulches or over the river bank. It is said that a part of the placers were worked for sapphires alone and the gold values sacrificed.

The Houser Lake dam, of the Missouri River Power Co., is about 1½ miles below Eldorado Bar, and will raise the water nearly 50 feet at the bar when completed. This will flood the lower western slope and will bring the water much nearer the placers, so that there will be less elevation for pumping if it should be desirable to obtain a supply of water for hydraulic mining in this way. Another electric power line crosses the bar.

Gruell Bar is about one-third of a mile wide and three-fourths of a mile long, and is said to contain over 160 acres. The edge of the bar is about 150 feet above the river, and the farther side is at least 50 feet higher. Placers were worked along the edge of the bar and about 200 yards farther back. The débris from the mining was washed over the edge of the terrace and into small draws. The gravel beds range in thickness from 3 to 15 feet where washed. The bedrock is chiefly red to purple slate with some sandy slate or quartzite. Bowlders of quartzite, limestone, slate, trap, andesite, gabbro, granite, etc., were observed in the débris piles. Epidote rock, quartz, flint, chalcedony, etc., are also present in the gravels.

Gruell Bar gives place to a large plain on the west, sloping gently to the river. Several prospect pits have been sunk on this flat, and a small amount of placer mining has been done.

The deposits on French Bar have been worked through a distance of over half a mile in an east and west direction and for a width of from 100 to 300 yards. The gravels lie at elevations of from less than 100 feet to about 200 feet above the river. The bar is crossed by several dry gulches that proved of value in mining. The gravel beds washed ranged from a few feet to 25 feet in thickness. The bedrock consists largely of purplish slate, some of which has been epidotized to hornstone. The débris contains bowlders and cobbles of quartzite, slate, limestone, flint, hornblende schist, diorite, monzonite, granite, and porphyries.

Spokane Bar is about 100 feet above the river, and has been worked for a distance of nearly three-fourths of a mile in a north of west and south of east direction, through a width of 50 to 200 yards. The bar passes into prairie country on the south, over which ditches were brought for sluicing and mining.

Montana sapphires were very favorably mentioned by J. Lawrence Smith [1] in 1873. George F. Kunz [2] describes the colors of the sapphires from the Missouri River deposits as varying "from light blue, lavender, light red, light green, to almost bottle green." They are "very dichroic, appearing blue or green when viewed across the

[1] Am. Jour. Sci., 3d ser., vol. 6, 1873, p. 185. [2] Mineralog. Mag., vol. 9, 1891, p. 396.

prism, but pink or red when viewed along the length of the crystal. They afford very brilliant gems with a remarkable luster; but no true (sapphire) blue or true (ruby) red crystals have been observed from this locality."

Dry Cottonwood Creek sapphires.—Dry Cottonwood Creek heads on the Continental Divide about 12 miles west of north of Butte, and its valley drains west entering Deer Lodge River 11 miles south of Deer Lodge. Sapphires have been found for a distance of several miles along Dry Cottonwood Creek, but the principal developments have been on the upper 4 miles of the South Fork. There are three or more holdings for sapphires along the creek. West Dodd, of Des Moines, Iowa, successor to the Variegated Sapphire Co., has the principal claims on the upper 2 miles of the creek down to the Grand Pre Flat. The Consolidated Gold & Sapphire Mining Co., of Butte, Mont., holds a number of claims extending from the Grand Pre Flat nearly 1¾ miles down the creek. A. D. Hoss, of Deer Lodge, and R. J. Dee, of Silverbow, own claims still lower down the creek.

Gold is associated with the sapphires in all the deposits and forms a large part of the values recovered in mining. The occurrence of sapphires and gold in the gravels of Dry Cottonwood Creek has been known for over 30 years, but mining for them along with gold has been carried on only at intervals. During 1910 a dredge was operated by the consolidated Gold & Sapphire Mining Co., and prospecting with a little placer mining was conducted by West Dodd and by Hoss and Dee. The flow of Dry Cottonwood Creek is small in the upper part, though sufficient for placer and limited hydraulic mining. It would be possible to add to the flow in the upper part of the gulch worked for sapphires by bringing in small flows from other tributaries of the creek. A dredge has been operated to within 2½ miles of the divide at the head of the creek and could have been worked through at least half a mile farther up stream. From the Grand Pre Flat down there is sufficient water for dredging or hydraulicking. Much of the gulch gravel could be sluiced or hydraulicked, as the grade is considerable, but the Grand Pre Flat and possibly one or two others would have to be dredged, as the grade is too slight to wash off the débris.

The valley of Dry Cottonwood Creek is semiwooded. Part of it consists of rounded grass-covered hills and part is covered by a thick stand of pine. The pine is rather small, but could be used in mining operations and much is now being cut for lumber. The forests on some of the hills have been devastated by fire and the dead fallen timber makes a rough country.

The claims of the Consolidated Gold & Sapphire Mining Co. extend from the fall line of the creek at the upper end of the gorge at an elevation of about 6,050 feet above sea level, and about 1¾ miles up the creek to the upper end of the Grand Pre Flat, at an elevation of about 6,175 feet. The gravel beds along the creek range in size from less than 50 feet to over 200 yards in width, and from 3 feet to at least 15 feet in thickness. The thickness of the gravel in parts of the flat has not been determined. The dredge has been started at the lower end of the claims and will be worked upstream. A pond in which to operate the dredge is made by excavating the gravel on the upstream side and piling the tailings on the lower side as a dam.

A bucket dredge with a belt-conveying tailing stacker is used. The sluice and riffles are made of suitable length and grade to catch both the sapphires and the gold in the first washing. The concentrates are further treated with special apparatus. The dredge is operated by steam power, for which cordwood is used as fuel. The rated washing capacity is 3,000 cubic yards in 24 hours, but in practice about 800 cubic yards are washed per day. The dredge was operated one month during 1909 and four months during 1910.

The West Dodd property extends from the upper end of the Grand Pre Flat, with a few breaks where the gravel beds are small, nearly 2 miles up the creek to about the upper limit of water. Sapphires have been found in placer mining to an elevation of 6,800 feet and in a test panning as high as 6,950 feet, the elevation of the highest spring on this fork of the creek. The bottom land gravels on the Dodd property range from a few feet to over 100 feet wide, and the bars in certain places are as much as 100 yards across. The gravels vary from 1 foot to 14 feet in thickness.

The dredge of the Variegated Sapphire Co. was operated on the present Dodd property during the summer of 1907 and one month in 1908. It is reported that the gold recovered paid the cost of operating during a part of the time, but failed to do so in the later runs, and since a satisfactory market for sapphire was not available it was necessary to stop operations. This dredge was of the bucket type and had a capacity of 750 cubic yards in 24 hours. It was operated by a steam engine and had a dynamo for its electric-light equipment. The material from the dredge buckets was washed in a revolving screen, from which everything over 1 inch in diameter was separated and turned into the pond under water at the back of the dredge, while everything under 1 inch in diameter was run over 50 feet of riffles. The débris was piled at the rear of the dredge, forming a dam and pond in which to operate. A square face was cut in the gravels across the gulch. The overburden was first removed for a width of 6 feet upstream and run directly through the dredge without washing. Gold and sapphires were caught in riffles, in which mercury was placed to hold the gold. The concentrates were treated for sapphires later with sieves and special apparatus.

Since 1908 only light prospecting work has been conducted, mining having been temporarily laid aside for the lumber and sawmill industry. At the time of examination (June, 1910) a series of trenches were being made across the gulch about one-fourth of a mile above the old dredge, with a view to determining the shape of the gravel bed, its richness, and the position of the values in both gold and sapphire. The gravel at this place ranged in size from a few inches thick on the side of the gulch to 12 feet and was about 40 feet across. It was composed of cobbles and partially rounded slabs of porphyry ranging up to several inches thick. The values in both gold and sapphire were found on and near bedrock.

The country rock of the sapphire deposits is composed of two principal types, granite and porphyry. The contact between these rocks is at the lower end of the Grand Pre Flat, the granite lying on the west and the porphyry on the east. The granite extends west at least as far as the gorge below the Consolidated Gold & Sapphire Mining Co. property. Porphyry outcrops to the summit of the divide on the east. A typical specimen of the granite, obtained

from a copper prospect about one-fourth of a mile below the contact, showed the following minerals under the microscope: Orthoclase, oligoclase, quartz, biotite, hornblende, magnetite, and apatite. It might be appropriately called either hornblende-biotite granite or quartz monzonite.

The porphyry country rock on the upper part of the creek presents slightly varied features, and there may be more than one intrusion of this rock. Much of it is typical granite or quartz-monzonite porphyry with a gray color and variations in texture. A few outcrops of grayish-white quartz porphyry were observed and on the divide dark gray rhyolite was associated with the granite porphyry. In thin section under the microscope, the granite porphyry is found to contain phenocrysts of quartz, orthoclase, oligoclase, and biotite with a little apatite and zircon in a groundmass. The groundmass contains incipient biotite crystals. Some of the phenocrysts are crushed and broken, and in places the fragments are isolated. In some hand specimens fragmental inclusions are observed. The porphyry on a hill locally called Volcano Hill, about three-fourths of a mile north of east of the Grand Pre Flat, is full of vesicular cavities like the blowholes in a lava. It also contains frequent inclusions of other rocks.

A thin section of the quartz porphyry under the microscope showed prominent quartz phenocrysts, with orthoclase and micrographic quartz, a little muscovite and apatite, with a groundmass. The groundmass contains incipient biotite crystals. Quartz porphyry outcropping above the upper placers on the creek contains pinkish-red garnets, some as large as peas.

The source of the sapphires is not known. Unauthenticated reports refer to both the garnetiferous quartz porphyry and to the granite porphyry in the upper part of Dry Cottonwood Creek valley. A careful examination of the quartz-porphyry locality failed to discover any sapphires in place. A tunnel and pits had been made at this place in decomposed porphyry. The material from the openings had slaked to a white crumbling mass. No sapphires were found in panning two buckets full of the slaked porphyry, but only a few garnet fragments and numerous glassy quartz crystals. Many specimens of the granite porphyry from different places along the creek and from the creek gravels were carefully examined for sapphires without success. A more detailed study of the region might discover other types of rock generally considered as a more common home of the sapphire. Prospecting for the sapphire matrix may with reason be carried on to an elevation of 7,000 feet on Dry Cottonwood, but the possibility of other bodies of such rock lower down the creek should not be overlooked.

The sapphires occur in rough crystals, irregular rounded masses, and as waterworn pebbles. The surfaces of many of those which are not much waterworn are strongly etched and corroded. The surfaces of a few of the crystals are curved, as is often observed on diamond. One yellowish-green sapphire crystal weighing a little over 4½ carats had very much the shape of a rough diamond crystal. This effect is due to a rather even development of the basal and rhombohedral faces, producing a form resembling an octohedron. This apparent octohedral form combined with marked curvature of the faces, peculiar etching, and luster due to high refractive index, produces the effect described. The sapphires obtained from the

lower part of the creek are more waterworn than those from the upper part. A few red and cinnamon-red garnets, mostly small, are found in the concentrates with the sapphires.

The larger part of the sapphire obtained in mining, either on account of small size or poor color, is best adapted to mechanical uses, and only a small part is suitable in size, color, and quality for cutting as gems. The predominant colors of the Dry Cottonwood sapphires are deep and light aquamarine and pale-yellowish green. Other colors are clear and smoky blue, light and dark topaz yellow, straw yellow, yellowish green like olivine, light and dark pink; some stones are nearly ruby red, pink, lilac, and pale amethystine, and some are colorless. The pleochroism of some of the sapphires is marked, the same crystal appering greenish when viewed across the prism and blue through its length, or pale and deeper pink, as the case may be. It is not unusual to find aquamarine-colored stones with a pink spot in the center. This combination furnishes a pleasing gem when cut. A feature of the deep pink sapphires is their rich and beautiful color under artificial light, even when they are not especially attractive in natural light.

INDIANA.

The occurrence of bronze sapphire in the glacial drift of Morgan County, Ind., was mentioned in this report for 1908 and in connection with diamonds in the report for 1909. The presence of gold in the glacial drifts of this region has been known for a number of years and a small amount of placer mining has been carried on for it. Scales and occasional nuggets of gold are found on the ledges in the stream courses, especially after heavy rains. Some of the natives make a pastime of searching for such gold, gathering the flakes on a knife point and transferring them to a vial. During the prospecting for gold 12 or 15 diamonds have been found associated with corundum, garnet, zircon, etc. The attention of R. L. Royse, of Martinsville, was attracted by the sheen of some of the bronze corundum pebbles and a few specimens have been cut "en cabochon." These stones give a cat's-eye effect when tipped back and forth, and one specimen reflected a strong brownish to reddish movable spot of light. The chatoyancy or sheen is due to minute regularly arranged inclusions in the corundum. Occasionally nearly clear bluish and grayish sapphire pebbles are found.

A deposit was examined on Highland Creek, about 7 miles west of north of Martinsville. In panning, colors of gold were found in many tests in the stream gravels, and a few flakes measured over a millimeter across. The concentrates cantained large quantities of black sands, composed of magnetite, hematite, pyrite or marcasite, titanic iron, with small quantities of corundum, garnet, zircon, etc. Pebbles of the same minerals are also present along with those of the associated rocks. Specimens broken from bowlders in the stream gravels consist of numerous basic rocks, as gabbro, diorite, diabase, and amphibolite, with some of granite, garnetiferous granite gneiss, pegmatite, etc. The country rock in this region is loose shale which has been lightly folded, though in places it is nearly flat. Much of it contains quantities of sulphide concretions, either marcasite or pyrite. The shale may belong to the Mississippian series, which

constitutes the lower part of the Carboniferous, and is certainly not older than late Devonian.

AUSTRALIA.

Queensland.—The production of sapphire in Queensland[1] during 1909 is estimated at £23,116, as compared with £15,000 in 1908 and £40,500 in 1907. Early in the year there was a strong demand for large fine stones, followed in the middle of the year by a demand for sapphires for mechanical purposes.

TURQUOISE.

NEVADA.

Otto Taubert turquoise mines.—Turquoise has been mined in two places in Lyon County, Nev., by Otto Taubert. The best of these deposits, which for convenience may be called mine No. 1, is a little over 7 miles N. 75° W. of Yerington, on the west side of the mountain ridge west of Walker River. The mine is situated in a low rounded hill in the rolling country about 1½ miles west of Mason Pass, at an elevation of about 5,350 feet above sea level. The other turqouise deposit, which may be called mine No. 2, is 1½ miles N. 25° W. of Yerington in a small group of hills in Walker River Valley, at an elevation of about 4,500 feet above sea level. An examination of the deposits was facilitated through the kindness of Mr. Taubert and his representative, Mr. E. J. Cooper, of Yerington.

The work at mine No. 1 consists of irregular open work 10 to 15 feet across and 2 to 8 feet deep, and a shaft 40 feet deep about 75 feet north of the open cut. The principal country rock is a bluish-gray and green granular porphyritic rock that may be monzonite or possibly andesite. This rock varies in texture and is partly altered or decomposed. The decomposition is greatest around the turquoise deposit and consists in both kaolinization and a little sericitization of the feldspars. Portions of the altered rock appear to be hardened by the presence of silica or quartz, probably set free during decomposition, and by iron oxides in seams. The badly decomposed rock is light colored to nearly white and does not much resemble the fresher rock. A ledge of green epidotized rock, possibly the same as the country rock, outcrops 75 yards northwest of the turquoise deposit. A vein of pale-green prase-like quartz outcrops on a small knoll 50 yards northwest of the turquoise workings. The greenish color is more prominent in surface material, that a little below the surface having a yellowish-gray color.

The turquoise occurs in seams and joints and occasional nodules in the altered rock. The joints are not especially prominent in any one direction, but are numerous. Many of them are stained by seams of limonite and iron oxide. The seams of turquoise range from mere films to seams one-half an inch thick and are not regular in size or direction. Some specimens of rock contain several branching or intersecting veinlets of turquoise. In color the turquoise ranges from dark sky blue to bluish-green to green. Much of it is very hard and the pure blue variety is slightly translucent and would

[1] Ann. Rept. Under Secretary of Mines, Queensland, 1909.

yield fine gems. Part of the turquoise, especially the greenish varieties, has patches and dendritic markings of limonite through it, giving a very pretty matrix stone.

A few small lumps of bright blue turquoise were found on the surface of an altered rock outcrop about 100 yards south of the main deposit.

The turquoise at mine No. 2 was found during prospecting for gold. A copper deposit has also been located about 100 yards east of the turquoise openings. Buildings have been erected for convenience in developing the different mineral deposits. The workings in which turquoise has been found consist of two pits about 100 yards east of the office and three shafts near the office. The workings were not in such shape as to allow a detailed examination of the formations encountered. The country rock is decomposed porphyry, probably granite, with a soft altered finer-grained rock, possibly trachyte, occurring as an intrusive. The turquoise occurs in both the altered granitic porphyry and the finer-grained porphyry as seams and nodular segregations. There is considerable soft pale-blue turquoise and some pure blue of a darker shade. Some of the finer-grained rock is stained by limonite, and in this the best turquoise appears to occur. Nuggets of good turquoise are reported to have been found in places in the shafts.

Carr-Lovejoy turquoise claims.—A little turquoise of good color has been found at two places on the Carr-Lovejoy group of variscite claims 9 miles east of north of Blair Junction. Prospecting work was limited at the time of visit, and accordingly only surface material was available for examination. The country rock is dull gray, slaty rhyolite, outcropping in rough rocky ledges. A few small dikes of a trachyte-like rock cut the rhyolite, and the turquoise is associated with these in small veinlets and seams with botryoidal, lumpy surfaces. Some of the turquoise has a very fine blue color and is especially hard. The veinlets exposed ranged up to one-fourth of an inch in thickness and show a tendency to occur as a streak of lenticular or nodular masses.

Riek & Botts turquoise claim.—Turquoise has been found on the Blue Bell turquoise-variscite claim of Carl Riek and W. K. Botts, 4 miles northeast of Coaldale. Turquoise occurs near each end of the claim, which is located on the west side of a rocky canyon. Prospecting was limited to a few pits and surface diggings. The country rock consists of slaty, dark-gray rhyolite and an altered porphyritic rock, probably quartz porphyry. The turquoise occurs in veinlets, seams, and small nodules in the rhyolite, which range up to an inch in thickness. Some of the turquoise is very hard and has a deep sky-blue color rarely excelled by that from any other locality. Specimens of matrix are obtained that have delicate brown cobweb markings and would yield beautiful gems.

Louis Sigmund turquoise claim.—Specimens of turquoise were kindly furnished by Mr. Louis Sigmund, of Mina, Nev., from new deposits discovered by himself about 3½ miles south of Redlich. Three claims have been located and two shafts started with some trench work. Mr. Sigmund states that the turquoise occurs in a porphyry formation with white and brown limonite-stained quartz. The turquoise is found mostly in nuggets and small seams. The

specimens examined were fine dark turquoise blue and greenish-blue and they were quite hard.

Dunwoody turquoise claims.—Turquoise of poor quality is found on the Clara and Halley's Comet claims of the Dunwoody-Prichard group of variscite claims 8 miles southwest of Sodaville. It is associated with both fine decomposed porphyry and dark-gray rhyolite; it fills seams and fracture zones with dark greenish-blue to bright-green material, and can with difficulty be distinguished from variscite. It contains copper as a coloring agent, however, and is therefore not variscite. The veinlets range up to three-fourths of an inch thick and some inclose fragments and breccia of rhyolite. The material from the Halley's Comet claim is also green and may be classed as semiturquoise. It could scarcely be distinguished from variscite without blowpipe or chemical tests.

Goldfield region.—Several parties produced turquoise in the Goldfield and adjoining regions during 1910. Some of this turquoise was found and mined during prospecting and mining for gold. Among the producers were Ad. Neher, M. L. Thompson, and George Keller, all of Goldfield. Turquoise was produced at the mines of Mrs. Eva S. Weber, of Belmont, Nev., but the principal work of the owner was in prospecting and mining metals. The Moqui-Aztec mine of S. Simmons, about 12 miles northeast of Sodaville, has been taken up by Jack Lippman, of Los Angeles, Cal., and a limited production of turquoise was reported during 1910. The Montezuma mine of the German-American Turquoise Co. in the same region has been taken up by the Western Gem Co., of Los Angeles. Both of these mines were described in this report for 1909.

VIRGINIA.

The following notes on crystallized turquoise from Virginia, a new occurrence of this mineral, are abstracted from a description by Waldemar T. Schaller to be published in a bulletin of the United States Geological Survey:

A specimen of well-crystallized turquoise from Campbell County, Va., was sent in to this office for identification by Mr. J. H. Watkins. The matrix of the specimen consists of irregular fragments of glassy quartz which are in part cemented together by thin veins of turquoise. On one side of the specimen the turquoise forms a drusy, botryoidal layer, cavernous in texture and including many small irregular fragments of the glassy quartz. The turquoise, with its many included quartz fragments, polishes well and makes a very handsome ornamental stone. The botryoidal coating consists of minute crystals, rhombic in shape but triclinic in symmetry, analogous to the crystals of chalcosiderite, with which turquoise is shown to be isomorphous. The analysis of the mineral, shown below, leads to the formula $CuO.3Al_2O_3.2P_2O_5.9H_2O$

Analysis of turquoise specimen from Campbell County, Va.

P_2O_5	34.13
Al_2O_3	36.50
Fe_2O_3	.21
CuO	9.00
H_2O	20.12
Total	99.96

Other analyses of turquoise yield formulas which are in close agreement with the one given above.

VARISCITE.

Continued new discoveries of variscite are being made in Nevada and Utah, and the location of several new prospects have been reported to the United States Geological Survey since the preparation of this report for 1909. In that report the deposits owned by the Los Angeles Gem Co., northwest of the old mining camp, Columbus, Nev., were described and a number of other newly discovered properties were mentioned. These deposits are described below. The "amatrice" variscite, mined by the Occidental Gem Corporation of Salt Lake City, and the "utahlite" variscite owned by Don Maguire, of Ogden, were described in this report for 1908.

The demand for variscite, especially the matrix varieties, has grown greatly in the last four years, and now large quantities are used in various forms of jewelry. The supply could easily be made greater than the demand, however, if all of the deposits were operated. As it is, this point has been nearly reached, so that only the better grades and odd varieties have found a market. Variscite can be used in many of the same forms of jewelry in which turquoise matrix is used. It will not wear as well as the turquoise, since it is of inferior hardness. The large variations in shades of color of both the variscite and its associated matrix, and the almost innumerable patterns and markings exhibited by them, make possible a wide range of gems adaptable to the tastes of many people. The color of most variscite is not easily susceptible to change, and is less so when the mineral is polished.

In general, there is a marked difference so far in the variscite found in Nevada from that found in Utah. Variscite has been found at four localities in Utah, in Utah, Tooele, Washington, and Boxelder counties. The greater part of the mineral from each of these localities is a brighter green than that from the numerous deposits found in Esmeralda County, Nev. There is also a variation in the colors of the variscite from the different localities of Utah, but the principal differences lie in the matrix and markings. There is more uniformity in color and types of markings in variscite from the several localities in Nevada. The common presence of a black phosphatic matrix with characters similar to variscite in the Nevada material is rare in the Utah gem material and seems to assist in giving the mineral a darker, less vivid green color. However, it is occasionally very difficult to determine from which State a certain stone may have come, and the gems that can be cut from nearly all of the deposits of variscite of either State have some desirable qualities.

NEVADA.

There are many points of similarity in the occurrence of variscite at the different deposits in Esmeralda County, Nev. The whole region is a desert with bare rocky hills on which there is a sparse growth of sagebrush, desert grass, and similar vegetation. Even the higher mountains are practically bare of trees. The lowlands generally consist of borax and salt marshes or dry sand flats. There are few springs, and water for drinking and other purposes has to be hauled to many of the mining camps, sometimes a distance of several miles. The heat is excessive in the summer and the climate is not mild in the winter. When rain does come it may be almost in the

form of a deluge. Variscite has been found at elevations ranging from about 4,700 to 6,700 feet above sea level. Some of the deposits are on steep rocky mountain sides and others are on the more gentle slopes. Turquoise has been found within a few yards of variscite in similar forms of occurrence at some of the deposits. In the descriptions given below magnetic readings are used, the variation being nearly 18° east of true north.

The rock with which the variscite is most commonly found is rhyolite. It has also been found in a trachyte-like rock, limestone, jasperoid, and sandy shale. The rhyolite is a dull light-gray to dark-gray and black chertlike rock. It is mottled in places and shows flow banding. In some outcrops the rhyolite resembles a sedimentary rock and is with difficulty distinguished from hard siliceous phases of the limestone and shales called "jasperoid" by S. H. Ball [1] in the country farther south. The rhyolite generally makes a rough country, outcropping in irregular masses and ledges with angular surfaces, and on breaking down covers the hills and slopes with sharp flaky fragments. The formations have been considerably folded near some of the deposits, and the consequent curving outcropping ledges of hard rhyolite can be seen across the country. Faulting and jointing has been extensive, also, and some of the fault zones are marked by much breccia. Small fault planes and joints have served as channels for the passage of solutions and the deposition of such minerals as variscite.

The limestone present around some of the variscite deposits is dark-gray to nearly black and contains many cherty and siliceous phases. The cherty portions, or jasperoid, outcrop in rough ledges and masses similar to the rhyolite. The occurrence of variscite in sandy shale is limited and was observed at the mines of the Los Angeles Gem Co. The trachyte-like rock has been observed at several of the deposits associated with variscite and is so badly altered that its true nature could not be definitely determined. It is generally present in dikes of small size to several feet across. Other formations occur in the region, but variscite has not been found associated with them. Some of these are sandstone, quartzite, quartz porphyry, somewhat altered, vesicular basalt, serpentine, etc.

The variscite occurs as a filling in fissures and joints, replacing other minerals, and as irregular and nodular segregations. The variscite not only fills many seams and joints in the rocks, but the crevices between shattered and brecciated fragments of rocks along the fissures. Thus brecciated zones more than a foot 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 individual seams of variscite vary from paper thickness to 2 or 3 inches in width. Locally they may bulge out into nodular masses several inches across. The variscite-bearing streaks and breccia zones may attain a thickness of over 4 feet, but even these are not rich in variscite for a distance of many yards. The different deposits in the same region have no connection with one another, but appear to be of local origin.

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

Candelaria variscite prospect.—Probably the first occurrence of variscite recognized in Nevada was that near the summit and on the opposite side of the mountain south of Candelaria. The deposit is close to the old workings of the Norton Bell silver mine, on the summit of the mountain, nearly a mile south of Candelaria and about a mile west of the Mount Diablo silver mine. The variscite prospect is in the eastern part of the Candelaria Mountains, at an elevation of about 6,525 feet above sea level, and the summit of the mountain near by is about 25 feet higher. The best mineral appears to have been found on the eastern brow of the hill, but other prospects have been opened on the steep slope below. At the time of examination (May, 1910) the name of George W. Brown was posted on the location monument, but the property is claimed by Edward Tilden, of Goldfield, by whom a production of variscite was reported in 1910.

The work consisted of an open cut with an incline shaft from its bottom and a prospect pit in a direction of N. 60° E. along the hillside. The country rock is principally dull-gray altered rhyolite that on casual inspection resembles limestone or limy slate. In places the rhyolite has a marked banding with occasional streaks of dark glass inclosing spherulites. The rhyolite has a strike of N. 60° E. and a dip of 45° NW. It is cut by a dike of altered trachyte-like rock at the variscite deposit. Both rocks have been fractured and some of the joints filled in with minerals. The summit of the mountain, a short distance to the northwest, is capped by vesicular basalt. The core of the mountain is probably serpentine, for a mass of this rock outcrops in the walls of Pick Handle Gulch to the northeast.

The variscite occurs along the contact of the rhyolite and trachyte in seams, veins, and occasional irregular masses and nodules in both rocks. The veins and seams fill joints and crevices, cutting the rock at all angles. Some of them split and branch out into two or more prongs. Some of the veins extend into breccia zones in which many angular fragments of rock, either the rhyolite or trachyte, are inclosed in variscite. The seams and veins of variscite range from paper thickness to half an inch in thickness. Most of the veinlets are less than one-fourth of an inch thick. The color of the variscite ranges from pale green to deep emerald green, which is partly translucent. Much of the variscite has an even pure color, but some of the thicker veinlets and masses are a little mottled with dark and light green, or are pale green in the interior, grading into dark emerald green on the borders. The variscite is close grained and compact, and ought to give good results as a matrix stone if polished along with a portion of the dark gray rhyolite or white to gray trachyte with which it is associated. Very few pure green stones of large size could be cut from the product of the Candelaria variscite prospect.

Coaldale region.—A group of variscite claims has been located 4 miles northeast of Coaldale, Esmeralda County, Nev., by G. E. Wilson, Abner Capps, Carl Riek, and W. K. Botts. These claims are in the rough country on the south side of the Monte Cristo Range, at elevations ranging from 6,150 to 6,700 feet above sea level. They extend through a distance of about three-fourths of a mile along a rocky canyon. Two adjacent claims, the Morning Glory

and the St. Patrick, owned by G. E. Wilson, lie principally on the hill on the southeast side of the canyon. Two others, the Bonnie Blue Bell and the Blue Bird, owned by Wilson & Capps, extend east and west across the canyon and overlap the Morning Glory and St. Patrick claims. The Blue Bell claim, owned by Riek & Botts, is on the northwest side of the canyon, along the top and side of the steep ridge forming the wall of the canyon. Both variscite and turquoise have been found on this claim. There is a spring a short distance northeast of the St. Patrick claim. At the time of examination (May, 1910) but little more than assessment work had been done on the claims. This consisted of open prospect pits and trenches and blastings in harder rock outcrops. On the Morning Glory claim a sloping pit 2 to 8 feet deep, 10 feet wide, and 35 feet long was made in the hillside. On the other claims smaller prospects had been opened and a few blasts put in the prospects that looked favorable.

The country rock is chertlike, gray to black rhyolite, which outcrops in hard rugged ledges along the canyon cutting the group of claims. There are a few small dikes of altered trachyte-like rock and some outcrops of large bodies of decomposed quartz porphyry in the vicinity. The quartz porphyry beds are as much as 200 feet thick in places, and one prominent bed outcrops along the west side of the canyon along the east line of the Blue Bell claim. The formations are folded and in places are very much contorted. The strike is in general to the north and the dip is variable.

On the Morning Glory claim a streak of variscite and matrix ranging from 1 to 4 feet thick was exposed in the open cut. The streak pinched down and bulged out quite irregularly and in places consisted entirely of phosphatic mineral, in part variscite and in part black mineral. The streak also contained rock breccia with variscite filling. A few veinlets of variscite could be traced from the end of the open cut northward up hill for a number of feet, and other veinlets outcropped in this line for a number of yards to the hilltop. The veinlets ranged from one-sixteenth to three-fourths of an inch in thickness. Some of the variscite from the open cut was finely marked with turtleback and other odd mottlings and occurred in large nodular pieces several inches across. The turtleback marking, composed of rounded patches of pale green variscite with a black matrix filling between them, would make a very fine matrix gem. The color of some of the other variscite from the main deposit and from the veinlets on this claim is dark green, and a black flinty brecciated matrix filled with this forms a beautiful contrast. Seams of variscite have been found at several places on the St. Patrick claim. Some of it has a good green color, and some has a black mottling.

Variscite has been found in seams, veinlets, and nodular masses on the Bonnie Blue Bell and the Blue Bird claims. The best deposits have been found on the east side of the canyon and are rather plentiful on the steep hillside. Some of the veinlets consist of streaks of nodular masses of variscite. Variscite of a deep green color and some mottled black matrix are found on these claims.

Variscite is found near the middle of the Blue Bell claim in small veinlets, seams, and nodules and loose in the surface débris. The

variscite has a good color, and the mottled black and green markings of some pieces are pleasing, but large veinlets or nodules are scarce. Turquoise is found at each end of this claim and is described under that mineral.

Another variscite claim has been located by Wilson and Capps on the west slope of the Monte Cristo range, about 3 miles east of north of Coaldale. The claim has an east and west extension on the steep rocky mountain side. A small gulch crosses its lower end. This deposit is about 2½ miles west of the claims just described. The rock is the same rough, cherty gray rhyolite containing a few decomposed porphyry streaks. The variscite occurs in veinlets and fills brecciated streaks of rock. Much yellowish-green variscite was found on the upper part of the claim and some with an emerald green in a small rocky gulch on the lower part.

Mr. Louis Sigmund, of Mina, Nev., kindly furnished specimens of variscite from a claim he has located about 6 miles northeast of Coaldale, or about 1½ miles northwest of the claims of Wilson, Capps, and Rick. The specimens consist of veinlets in cherty rhyolite, sheets with botryoidal surfaces from veinlets, and nodular variscite in black matrix. The specimens of the veinlets and botryoidal variscite have a good green color and some is finely marked with black. The nodule is a light green and has a turtleback mottling.

Another variscite claim has been located by M. M. Holland, about 5 miles northeast of Coaldale, and a small production of gem was reported in 1910.

Blair Junction region.—Nine claims for variscite and turquoise have been located by Clyde Carr and Mrs. Mattie Lovejoy in the Monte Cristo range, about 9 to 11 miles east of north of Blair Junction. These claims lie at elevations ranging from 6,200 to 6,600 feet above sea level along the northeast side and top of a ridge. The country is broken by numerous rocky draws and gulches from 50 to 200 feet deep, heading along the ridge. The claims are grouped end to end in two adjoining rows with a northwest-southeast trend. There are five claims in the northeast row named Mars, Wren, Comet, Azure, and Green Fly from southeast to northwest, and four claims in the southwest row named Lulu, Long Chance, Jupiter, and Progress. There is a spring near the Progress claim. The variscite of this region was discovered by Mrs. Lovejoy in January, 1910. Locations were made in partnership with Mr. Carr, as new prospects were discovered. The quantity of work done on some of the claims is in excess of that required for the assessment. The openings consist of cuts, pits, and shallow shafts.

The country rock is principally dull gray to black chertlike rhyolite, the harder beds of which outcrop as rough, rocky ledges. The rhyolite is cut by small dikes of altered quartz porphyry or trachyte, and in places by larger masses of such rock. One of the porphyry masses near the northwest end of the claim was about 100 feet thick. Limestone and jasperoid outcrop in the region adjoining the variscite deposits. The bedding of the rhyolite strikes about northwest with a variable southwest dip. The rocks have been folded and in places are broken by fault zones filled with breccia. The variscite occurs in nodular masses, seams, and veinlets, principally in the rhyolite. The greater part of the gem material comes from cross veinlets striking about northeast with nearly vertical dips, but some good

colored variscite is found in seams cutting the formations in other directions. The veinlets with a northeast trend are the thickest and are more continuous in length than the others. Good variscite matrix is also obtained from breccia zones and from nodular segregations in them and in other veins cutting the rock.

Several prospects have been located on the Comet claim and variscite has been found in both veinlets and nodular segregations. Some of the variscite in the seams has a good dark-green color. Masses of nodular material are found composed of round balls of pale grayish-green variscite with black rims around them in grayish and yellowish-colored matrix. The whole is compact and has a fairly even grain, so that it ought to polish well and would yield an attractive unique gem. Considerable of this material was found loose on the ground at one place. On the Azure claim a streak of black matrix with variscite 6 to 20 inches thick was opened in a cut. Part of the variscite in this black matrix has a fine green to bluish-green color, and some occurs as rounded masses in the black, yielding a beautiful mottled matrix. In places nodules of pure dark-green variscite an inch across are found in the black matrix. On another part of the Azure claim nodules of variscite were found along a small altered trachyte dike. This material was largely pale yellowish green, and not of gem grade. In another place several veinlets of variscite were found in an open cut.

Variscite is exposed in an open cut and in the rock outcropping in the hill above it, near the northwest end of the Mars claim. Some of the veinlets are as much as an inch thick and can be traced a number of feet in a northeast direction.

Variscite has been found at several places on the northwestern half of the Wren claim, and part has not been worked below the outcrop, while part has been opened by prospects. In one of the cuts three large veinlets ranging up to 3 inches thick were exposed, one of which can be traced nearly 100 feet on the outcrop from the cut. Some of the variscite occurs in nodules with mottled black matrix markings. A seam of translucent dark-green variscite, resembling chrysoprase in color, up to half an inch thick, has been found on this claim. It has botryoidal surfaces in places and is very hard. In another cut several veinlets of variscite with brecciated and nodular variscite were found. This variscite ranges from pale green to dark green and part is mottled and speckled with black matrix. Outcrops of other veinlets of variscite with apple green and light to dark green shades have been found on the Wren claim.

The work on the Green Fly claim to the northwest was not so extensive as on the others, as the outcroppings were not so promising. On the Progress claim nodules of pale bluish-green variscite giving coarse turtleback markings were found loose on the surface. These nodules range in size from one-half inch to 2 inches in diameter and would yield odd-looking gems. At one place, on the Jupiter claim, a prominent veinlet of light grayish-green variscite was found projecting above the inclosing rock an inch or two. In a pit at another place seams of yellowish-green and green variscite and yellow phosphatic nodules were found. The phosphatic nodules range in size up to 2 inches in diameter and some would give turtleback effects if cut. On the Long Chance and the Lulu claims several small seams of variscite and a little float material have been found. On the

Lulu claim turquoise of good color has been found, and is described under that mineral.

Sodaville region.—A group of variscite claims has been located about 8 miles southwest of Sodaville by Mrs. Clara Dunwoody, C. M. Dunwoody, and C. Prichard. These claims are in the rough, broken country at the east end of the Excelsior Mountains. The elevation of the lowest point on the claims is about 5,300 feet above sea level, and that of the highest point about 6,300 feet. There are six claims along and on the sides of and at the head of a rocky gulch or canyon from 300 to 600 feet deep. The gulch has a southeast course and debouches on a long slope extending down to the valley of the Rhodes salt marsh. The names of the claims are the Variscite No. 1, Variscite No. 2, King Solomon, Clara, Blue Bird, and Halley's Comet. Numerous prospect pits have been made on the claims, with a cut 25 feet long, 5 feet wide, and 2 to 10 feet deep on the Variscite No. 1 claim.

The country rock is chertlike gray to black rhyolite, which has harder, more resistant siliceous beds. These beds outcrop as rough ledges 10 to 20 feet thick, across the country. The rhyolite is cut by dikes of altered light-colored porphyry or trachyte, both parallel with and across the bedding. The formations have been considerably folded and across the canyon south of the variscite deposits a large synclinal fold can be plainly seen by the curved outcrops of the hard siliceous rhyolite ledges. The variscite occurs principally in seams, but some nodular masses are found. The variscite is associated with the rhyolite and occurs in seams and nodules in the altered porphyry. Greenish-colored turquoise also occurs in the altered porphyry.

On the Variscite No. 1 claim a veinlet of variscite was found filling a prominent joint that could be traced for about 100 feet in a direction N. 60° W. This veinlet stood about vertical as exposed in the open cut. Another parallel seam, but less continuous, and several short veinlets crossing the main one were found. The variscite varies from light to dark green. On the Variscite No. 2 claim two veinlets of variscite one-sixteenth to three-fourths of an inch in thickness were exposed in an open cut 15 feet long and 5 feet deep.

Good variscite has not been found on the King Solomon claim. A soft bluish-white mineral occurs in altered porphyry in seams and nodules like turquoise or variscite. It has a hardness of about 2.5 when dry and resembles halloysite or a similar variety of clay-like mineral. Both variscite and turquoise are found on the Clara claim and the turquoise is mentioned under that mineral. Some of the variscite has a fine green color and occurs in veinlets up to 2 inches thick and in breccia zones 5 inches thick. Fine specimens of variscite inclosing black matrix breccia have been found on this claim. Variscite has been found at several places on the Blue Bird and Halley's Comet claims, and semiturquoise on the latter claim. The variscite occurs principally in veinlets and seams, but there is nodular material. Part of it is of good quality and is dark green.

UTAH.

The variscite deposits 5 miles northwest of Lucin, Utah, were first opened by C. J. Burke in 1902, by a shaft 22 feet deep, in search for gold. The claims were abandoned, however, since no gold was found.

The variscite was rediscovered by Frank Edison in 1905, but was not taken up until August 3, 1909, at which time the present claims were located. The locators and owners are Frank Edison and Edward Bird. Mr. Bird is the discoverer of the variscite deposit in Tooele County, Utah, from which "amatrice" is obtained.

The deposits are in the northern part of an irregularly shaped hill, called Utahlite Hill. Utahlite Hill is about 1 mile long in a northwest-southeast direction and about one-half mile wide. It has an elevation of about 5,000 feet above sea level and rises over 300 feet above the mesas and gentle slopes at its base, and about 500 feet above the railroad at Lucin. The variscite deposits are in the higher parts of the hill.

Four claims have been located and these are, in order from northwest to southeast, Utah Gem, Greenback Lode, Utahlite, and Protection Lode. These claims adjoin one another with their longer directions parallel. The best showing for gem material is on the Utahlite and the Utah Gem claims. On each claim the mineral is in and around small rocky summits standing above the rest of the hill. These summits have cavities and small caverns around the sides of the rocks resembling those made by wave action. They were probably formed on one of the shore lines of the former Lake Bonneville. The work done at the time of examination consisted of an open cut 50 feet long and 2 to 5 feet deep, with several prospect pits.

The rock in which the variscite occurs and which forms the crest of the hill is cherty or chalcedonic quartz, which contains inclusions of nodules and streaks of limestone. The limestone inclusions range up to a foot thick and in places are several feet long. The character of most of the rock is that of a hard breccia cemented together by silica. This breccia forms rough rocky ledges and knobs rising from a few feet to 25 feet above the hill slopes. The bedding of the limestone-bearing chert is about northwest, with a dip to the northeast. Many joints cut the rock with a similar strike, but southwest dip. The surfaces of the hill below these outcrops are covered with detritus and loose rock, so that the formations at a lower level do not outcrop near the variscite deposits. Three of these knobs contain large quantities of variscite.

The variscite occurs in balls, nodules, and irregular masses in the chert. Veins of variscite are not common, but some with a northeast strike and northwest dip were seen on the Utah Gem claim. The nodules and balls of variscite range in size from a fraction of an inch to several inches across and some of the segregations of variscite inclosing matrix are a foot across. The variscite fills fractured and brecciated zones in the rock, some of which it replaces, and it incloses other parts. The replacements are generally rounded, concretionary masses often with banded concentric structure. The fragments of some of the brecciated rock, especially white quartz, that have been inclosed by and cemented with variscite have remained angular and sharp. Some of the concretionary forms appear to grade from green variscite cores into the inclosing yellow, brown, gray, and white phosphatic and cherty minerals. There is considerable chalky mineral filling cavities in the variscite-bearing rock and coating the nodules and masses of variscite. A quantity of variscite pebbles and cobbles has been found in the cut in the loose detritus below the main outcrop on the Utahlite claim. These probably owe a large

part of their rounded form to the nodular shape of the variscite in the original rock, but have also probably been rounded by water action on a former lake shore. The pebbles are coated with a white chalky substance, and have to be broken into before the presence or quality of the variscite can be determined.

The matrix with which the variscite is associated is chiefly silica, either chert, chalcedony, or quartz. Some other phosphatic minerals, in part probably allied to variscite, are often present. Both the variscite and the matrix minerals possess various shades of color, several of which are sometimes present in a single specimen. The different colors combined with the various markings and patterns due to the structure of the mineral and the brecciation of the matrix furnish a large range in the types of stones that can be cut from the variscite. The variscite ranges in color from very pale green through different shades of green to bright grass green. The matrix varies from white to gray, to yellow, to brown, and nearly to black.

The gems that can be cut from the variscite from the Edison and Bird mine range from large pure stones with light to dark green color through those with small quantities of matrix to those in which the matrix predominates. The dark and bright green variscite is obtained in pieces that will cut into pure stones measuring more than an inch across, and paler-colored mineral will yield even larger pure stones. Some of the bright-green variscite is partly translucent, and thin pieces and small pebbles display their color well in the partially transmitted light. This is especially true of the coarser-grained, finely crystalline variscite. Specimens of matrix are obtained that will yield slabs 6 inches across, some of which show quite remarkable patterns and colors. One block of matrix found at this mine measures 4 to 6 inches in diameter and weighs several pounds. The whole mass is composed of variscite mottled with brown and white matrix. The pattern is the typical turtle-back and the markings are coarser in some parts of the specimen than in others. The markings are due to rounded patches or nodules of pale to bright green variscite, some of which are surrounded by rims of white or gray and all filled in with purplish brown matrix. The brown matrix occurs only as an internodular filling and the seams are rarely over a millimeter thick. Occasional larger patches of matrix occur where several seams meet around the variscite nodules. The rounded masses of variscite vary from a fraction of a millimeter to a centimeter in diameter. Other smaller pieces of mottled variscite have been found along with specimens of brown, gray, and white matrix, with practically the same texture. Some pieces of mottled matrix contain little, if any, green variscite, but would cut into stones with the turtle-back markings.

Among other types of variscite matrix is that with bright grass-green variscite mottled with patches and cloudlike masses of lighter green material, or vice versa. Such matrix may contain seams and spots of white, gray, or yellowish mineral through it. A white quartz breccia cemented and filled in with bright green variscite is also a pleasing stone when cut, but is more difficult to polish because of the difference in hardness of the two minerals. The quartz occurs in sharp angular fragments, which are in excess of the variscite in some specimens but generally less prominent.

The variscite and variscite matrix from this locality would yield very beautiful gems for the so-called barbaric jewelry. It is susceptible to nearly every form of cutting used with opaque gems, but on account of its comparative softness is not adapted to rough wear. For necklaces, pendants, brooches, pins, belt stones, etc., it is well suited. The especially bright colors of some of the variscite from this locality are rarely found in that from other places, and the variety of markings shown by the matrix is probably equal to any other material found. The brightest green occurs in masses of granular variscite, the coarse varieties of which are not sufficiently compact to cut for gems. The granular variscite has been investigated by Waldemar T. Schaller, who has prepared the following abstract from his description to be given in a bulletin of the United States Geological Survey:

Another phase of the mineral is where it exists as a granular aggregate of well-formed rectangular crystals, the largest of which are about a millimeter long. The crystals are orthorhombic in symmetry and similar in the values of their crystal angles to those of scorodite and strengite. The variscite crystals are vivid green in color, but when heated before the blowpipe the green color changes to a deep lavender. This change of color will also take place at as low a temperature as 160° C., at which temperature all of the water of the mineral is given off. Together with these changes the optical properties are likewise profoundly affected, the refractive indices and the double refraction becoming much less. It was found that a small amount of chromium and vanadium is present in the mineral, and chemical analyses gave the following values:

H_2O	22.68
P_2O_5	44.73
V_2O_3	0.32
Cr_2O_3	0.18
Fe_2O_3	0.06
Al_2O_3	32.40
Total	100.37

The ratios calculated herefrom are $4H_2O.1P_2O_5.1Al_2O_3$, the analysis confirming the formula $AlPO_4.2H_2O$, already established for the mineral.

MISCELLANEOUS.

COPPER ORE GEMS.

ARIZONA.

Mr. John F. Gross, of Chloride, Ariz., kindly supplied specimens of copper-stained rock from about 24 miles northwest of Chloride. Some of it has been cut with good results. The color is the usual blue of many copper salts, mottled with patches and tufts of green and occasionally of red, brown, and white. Some of the rock is fine-grained, altered quartz porphyry which has been heavily stained with copper and hardened by silica or chalcedony. The green spots are tufts of malachite and the red is due to small quantities of hematite. The rock is compact and fairly hard, so that it should receive a good polish. Another specimen examined consists chiefly of fractured glassy quartz, with the blue copper stains and patches of malachite throughout.

BEACH PEBBLES.

CALIFORNIA.

Specimens of beach pebbles found on the southeast end of Santa Catalina Island were kindly furnished by the Catalina Novelty Co., of Avalon. This material has been cut under the name first of "Catalina sardonyx" and then "catalinite." It consists of mottled green, gray, white, yellow, brown, and red minerals which have not been given sufficient study for identification. All are sufficiently hard and compact to receive a good polish. The gems cut from this material are very odd and pretty.

PRODUCTION.

There was a decrease in the quantity of the production of precious stones during 1910, and this was accompanied by a large decrease in value. The large decrease in the output of a few of the more important gem minerals—as tourmaline, turquoise, chrysoprase, etc.—readily accounted for the fall of the value of the production from $534,380 recorded in 1909 to $295,797 in 1910. There were changes, both increases and decreases, in the production of other gem minerals, but their effect on the total figures was small compared with that of the minerals mentioned above.

Attention is called to the fact that in a number of cases it has been necessary to estimate the value of the production of certain minerals, in part or wholly, from the quantity of the output. In doing so the values given are as nearly as possible those that a miner would receive in selling rough gem minerals to the dealers. It should be understood that after changing hands and the application of labor on the minerals the value increases more than proportionately to the cost of the labor. The value of the elaborated gems obtained from the output of rough gem material in the United States is several times more than that given in the table of production. The table therefore serves as a basis of estimation and is not to be taken as an accurate statement of the value of the output. It is not possible to obtain statements of the output of all varieties of gem minerals each year, as such minerals originate from new sources and pass through the hands of different dealers, all of whose names are not on the Survey lists, or of people who do not cooperate in the work of collecting such statistics. Dealers who learn of new sources of supply or purchase gem minerals from intermittent producers will greatly help in the preparation of these reports by supplying information on such subjects.

Production of precious stones in the United States in 1907, 1908, 1909, and 1910.

	Value.				Remarks.
	1907	1908	1909	1910	
Agates, chalcedony, etc., moonstones, etc., onyx.	$650	$1,125	$750	$2,268	About 1,150 pounds; California, Colorado, Montana, and Wyoming.
Amethyst	850	210	190	.....	No production reported.
Azurmalachite, malachite, etc.	250	5,450	2,000	550	475 pounds; Arizona and Nevada.
Benitoite	1,500	3,638	500	.....	No production reported.
Beryl, aquamarine, blue, pink, etc.	6,435	7,485	1,660	5,545	About 30 pounds rough and selected.
Californite	a 25,000	.....	a 18,000	a 8,000	1,500 pounds; California; not sold.
Catlinite	25	.....	.....	.....	No production reported.
Chiastolite	20	.....	.....	.....	Do.
Chlorastrolite	.....	25	2,400	a 2,000	1,250 pounds; Michigan.
Chrysocolla	150	600	300	.....	No production reported.
Chrysoprase	a 46,500	a 48,225	a 84,800	a 9,000	1,700 pounds; California.
Cyanite	100	.....	.....	.....	No production reported.
Diamond	a 2,800	a 2,100	2,033	a 1,400	208 stones; Arkansas and California.
Diopside	.....	120	.....	.....	No production reported.
Emerald	a 1,320	.....	a 300	a 700	North Carolina.
Epidote	60	.....	15	.....	No production reported.
Feldspar, sunstone, amazon stone, etc.	1,110	2,850	a 2,700	2,510	4,128 pounds; Colorado and California.
Garnet, hyacinth, pyrope, almandine, rhodolite.	6,460	13,100	1,650	3,100	151 pounds; California, Arizona, and Colorado.
Gold quartz	1,000	1,010	.....	1,000	Colorado and California.
Jasper	675	.....	100	475	500 pounds; Colorado and California.
Opal	180	50	200	270	Nevada.
Peridot	1,300	1,300	300	.....	No production reported.
Petrified wood	325	.....	.....	.....	Do.
Phenacite	25	95	50	50	Colorado.
Prase	.....	.....	.....	100	50 pounds; Oregon.
Pyrite	400	.....	.....	.....	No production reported.
Quartz, rock crystal, smoky quartz, rutilated, etc.	2,580	3,595	2,689	1,335	1,753 pounds; Colorado, Maine, Vermont, California, and Texas.
Rose quartz	6,375	568	2,970	2,537	25,025 pounds; South Dakota and California.
Rhodocrosite	150	.....	.....	.....	No production reported.
Rhodonite	.....	1,250	125	a 6,200	3,200 pounds; Montana and California.
Ruby	2,000	.....	.....	.....	No production reported.
Rutile	200	.....	25	.....	Do.
Sapphire	a 229,800	a 58,397	a 44,998	52,983	1,062,000 carats; Montana and Indiana.
Smithsonite	800	a 1,200	300	.....	No production reported.
Spodumene, kunzite, hiddenite.	14,500	a 6,000	15,150	33,000	120 pounds; California.
Thompsonite	.....	35	100	610	About 50 pounds; Michigan, Minnesota, and New Jersey.
Topaz	2,300	4,435	512	884	75 pounds; California, Colorado, and Texas.
Tourmaline	a 84,120	a 90,000	a 133,192	a 46,500	1,548 pounds; California and Maine.
Turquoise and matrix	23,840	a 147,950	a 179,273	a 85,900	16,886 pounds; Nevada, New Mexico, Arizona, and Colorado.
Variscite, amatrice, utahlite	7,500	14,250	35,938	a 26,125	5,377 pounds; Utah and Nevada.
Miscellaneous gems	.....	.....	1,060	2,755	Datolite, obsidian, fossil coral, and ornamental stones with trade names.
Total	471,300	415,063	534,380	295,797	

a Estimated or partly so.

IMPORTS.

The importation of precious stones into the United States in 1910, as reported by the Bureau of Statistics, showed a slight increase over that of 1909. The principal increases were in the imports of pearls, rough or uncut diamonds, and diamonds and other stones not set. There was a decrease in the imports of cut diamonds. The importation of rough diamonds has not yet returned to the high level preceding 1907.

The following table shows the value of the diamonds and other precious stones imported into the United States from 1906 to 1910, inclusive:

Diamonds and other precious stones imported and entered for consumption in the United States, 1906–1910.

Year.	Diamonds.					Diamonds and other stones not set.	Pearls.	Total.
	Glaziers.	Dust or bort.	Rough or uncut.	Set.	Unset.			
1906	$104,407	$150,872	$11,676,529	$305	$25,268,917	$3,995,865	$2,405,581	$43,602,476
1907	410,524	199,919	8,311,912	.....	18,898,336	3,365,902	680,006	31,866,599
1908	650,713	180,222	1,636,798	.....	9,270,225	[a] 1,051,747	910,699	13,700,404
1909	758,865	50,265	8,471,192	.....	27,361,799	[a] 3,570,540	24,848	40,237,509
1910	213,701	54,701	9,212,378	.....	25,593,641	4,003,976	1,626,083	40,704,487

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