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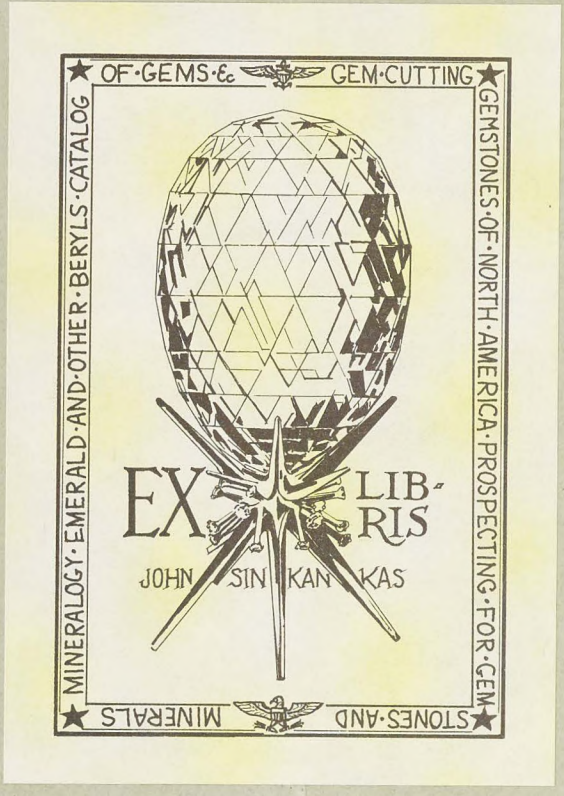
MINERALS FROM THE PEGMATITE VEINS OF RINCON, SAN DIEGO CO., CALIFORNIA

By AUSTIN F. ROGERS

[Reprinted from the SCHOOL OF MINES QUARTERLY, VOL. XXXI., No. 3.]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MINERALS FROM THE PEGMATITE VEINS OF RINCON, SAN DIEGO CO., CALIFORNIA.

BY AUSTIN F. ROGERS.

During a trip to San Diego Co., California, the writer collected a suite of minerals from the pegmatite veins at Rincon, in the northern part of the county on the San Luis Rey River. It was through the courtesy of Mr. C. J. Moore, of Palo Alto, that the writer was able to collect these interesting specimens.

There are three principal veins on which claims have been located and on which a certain amount of quarrying for gems has been done. These are named the Victor, the Rincon and the Mack. The veins vary in width from three to ten feet and have a dip of 40 to 50° toward the west or southwest. The veins are granite-pegmatites and consist principally of quartz, orthoclase and muscovite, which are arranged in bands parallel to the walls of the vein. The bands are due to variation in the coarseness of the grain as well as to the presence of certain minerals. Along the median line of the vein are lens-shaped pockets which contain the lithium-bearing and associated minerals for which San Diego Co. is so famous. The pegmatite on the Victor claim has the greatest variety of minerals and is the most interesting for study.

The main points of this paper are the descriptions of bismite (found for the first time in crystals), pleonaste, cookeite and zeolites which have never been described from this district before, the description of a unique type of lepidotite crystals and the paragenesis of minerals in the Victor pegmatite vein.

DESCRIPTION OF THE MINERALS.

Bismuth in small, bright metallic cleavages occurs in the lepidotite of the Victor vein.

Bismite is associated with the bismuth as a bright yellow oxidation product. For the most part it consists of irregular particles, but several minute crystals (Fig. 1) were found with the microscope. The tabular crystals lie on the 100 face and are terminated

by 011 faces. The angle (011 ∧ 0$\bar{1}$1) is 94°, the recorded value being 93° 34′. The crystals have parallel extinction, elongation parallel to the slower ray and the interference colors are often the abnormal Berlin blue. Natural crystals of bismite have not previously been described but our crystals agree with the description of the artificial Bi_2O_3.*

Quartz.—Crystals from this locality have been described by Waring.† Most of the crystals are singly terminated, about 1 cm. in diameter and 2 or 3 cm. in length. The principal forms are 10$\bar{1}$1, 01$\bar{1}$1, 10$\bar{1}$0, 11$\bar{2}$1 and 51$\bar{6}$1.

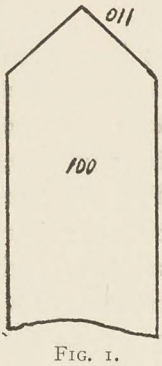

FIG. 1.

Twin crystals with 10$\bar{1}$0 as twinning plane are common. Small doubly terminated opaque white crystals of long prismatic habit occur in cavities and probably represent a second generation of quartz.

Hyalite occurs as a secondary mineral, forming a thin coating on some of the quartz crystals and albite crystals. It is glassy, transparent with botryoidal surface and is very brittle. Infragments the hyalite shows very weak double refraction and some of them give an imperfect spherulitic black cross which means that the brittle character is due to strain.

Spinel.—The iron-bearing spinel, pleonaste, is found in two of the veins at Rincon in small (.25 mm.) crystals associated with small garnet crystals. A few imperfect octahedra were isolated. In fragments the mineral is perfectly isotropic, deep green in color, and its index of refraction is greater than that of methylene iodide which distinguishes it from other varieties of spinel. Blue spinel has been reported‡ from Rincon but was not found by the writer.

Orthoclase is a prominent constituent of the veins, but is rarely well crystallized. Several imperfect, somewhat distorted crystals are rather tabular, parallel to 010 and elongated in direction of the *c*-axis. The forms observed are 001, 010, 100, 110, 130, $\bar{1}$01, $\bar{2}$01 and $\bar{1}$11. A few Baveno twins were found.

Most of the orthoclase at this locality is perthite, an intergrowth

* Groth, "Chemische Kristallographie," part 1, p. 109.

† *Am. Jour. Sci.* (4), 20, 125, 1905.

‡ Bull. 37, Cal. State Min. Bureau, p. 48, 1905.

of orthoclase with thin plates of polysynthetically twinned albite usually approximately parallel to the 100 face. The orthoclase is clear and weathers away easily, leaving ridges of albite which is more opaque. These corroded specimens are often covered with a secondary parallel growth of clear, glassy orthoclase. In one specimen this secondary orthoclase had a narrow 100 face.

In a pale brown perthite specimen the plates of albite are set parallel to the 110 face.

Microcline.—Part of this pale brown feldspar is microcline. The hand specimen shows a checked appearance on the basal cleavage. A thin section exhibits the characteristic twinning of microcline. This microcline-perthite has albite lamellae inserted parallel to 100 and also parallel to 110 as the angle between the traces of 100 and 110 on 001 measures 34° as against the theoretical angle of 33° 22′, which is $\tan^{-1} 0.6585$ (à axis of orthoclase). This specimen shows incipient alteration along the cracks between microcline and albite.

Albite is a prominent mineral of the veins. At the Victor mine it occurs in crystals of the usual habit, tabular parallel to 010, about 1 mm. thick and about 1 cm. in the direction of the *c*-axis. The forms are 010, 001, 110, $1\bar{1}0$, $\bar{1}30$, $1\bar{3}0$, $\bar{1}01$, 201, $\bar{1}11$ and $\bar{1}\bar{1}1$. The forms 001 and $\bar{1}01$ are usually in equal combination. The crystals are invariably twinned, usually according to both the albite and Carlsbad laws. A single albite twin and a single Carlsbad twin were observed. The compound twins are of two kinds: (1) Two halves of a crystal are twinned according to the Carlsbad law and each of these has polysynthetic twins according to the albite law; (2) an albite twin has a small crystal tacked on one side and united according to the Carlsbad law.

At the Rincon mine the albite occurs in sub-parallel aggregates which are comparatively thick in the direction of the *b*-axis and have very short 110 faces, thus approaching the pericline habit. The crystals are albite twins with the forms mentioned above.

Spodumene.—The Kunzite variety of spodumene occurs in the clay pockets at the Victor mine and some gem material has been obtained. The crystals in habit and appearance resemble those described by Schaller* from Pala, but are more perfect, though

* Bull. Dept. Geol. Univ. of Cal., 3, 265, 1903.

smaller and paler in color. The habit is tabular to 100; 110 is prominent, and 010 usually narrow. The prisms 320 and 130 were noted on several crystals. A few crystals show terminal forms 021 and $\bar{1}11$. The new form 111 was observed on one crystal (Fig. 4).

Kunz,* who first described this mineral, mentions twinning as a prominent feature, while Schaller† says that his crystals showed no evidences of twinning. Among the Rincon crystals, however, are many undoubted twins. The evidence for twinning is based

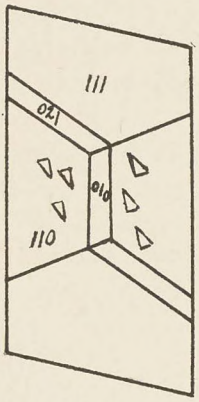

FIG. 2.

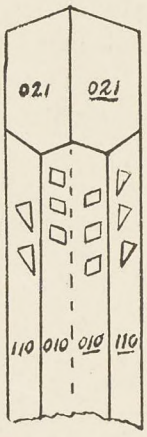

FIG. 3.

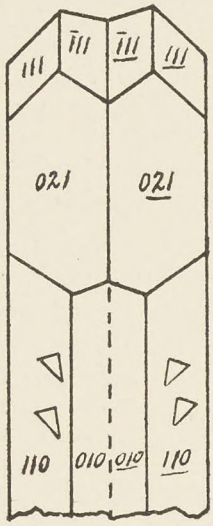

FIG. 4.

upon an examination of the natural etch-figures, which are so characteristic of the unit prism faces. The etch-figures are triangular in form and agree exactly with the description given by Schaller. The acute angle of the etch-figure on the front 110 face points downward. In an untwinned crystal the acute angle on the back $\bar{1}10$ face points upward (Fig. 2) while in a twinned crystal (100 being the twin-plane) the acute angle on the back face $\bar{1}10$ points downward (Figs. 3 and 4). Fig. 2 is an untwinned crystal with 021 as the dominant terminal form.

Fig. 3 represents a twinned crystal in which the twinning is

* *Am. Jour. Sci.* (4), 16, 264, 1903.

† *Loc. cit.*

apparent from an inspection of the etch-figures on 010 as well as those on 110. Fig. 4 is a twinned crystal with the new form, {$\bar{1}11$} which was established by contact goniometer measurements ranging from 48° to 51°, the calculated value being 50° 36′. Fig. 5 is a sketch of a prism face with etch-figures. The right half is a $1\bar{1}0$ face while the left half is a 110 face in twinning position to it. These two faces are in one plane on account of twinning.

Beryl.—At Rincon beryl occurs in several varieties. Ordinary greenish subtranslucent crystals of prismatic habit up to 10 cm. in length have been found. Aquamarine crystals of slender prismatic habit usually small and often needle-like have been found

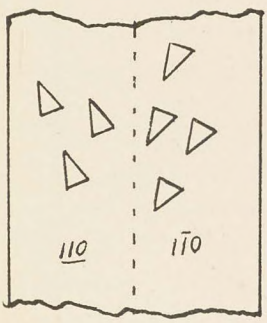

FIG. 5.

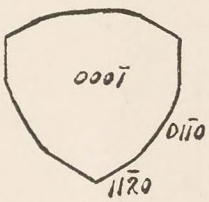

FIG. 6*a*.

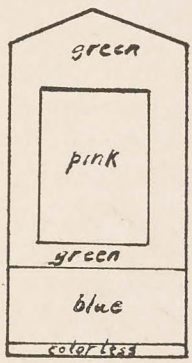

FIG. 6*b*.

in the Rincon mine as well as a few magnificent clear sea-green crystals of gem quality about 5 cm. long. The aquamarine crystals are usually terminated by 1011, $11\bar{2}1$ and 0001, the latter face being very brilliant. The prism faces include $21\bar{3}0$ in addition to $10\bar{1}0$. A typical crystal has been figured by Ford.* A few transparent pale pink beryls of thick tabular habit were found at the Victor mine. One crystal measured 18 mm. by 25 mm. and had small faces of $11\bar{2}1$ and $21\bar{3}1$ in addition to the dominant forms, 1011 and $10\bar{1}0$.

Garnet.—In the so-called line-rock (granulite) there are minute red garnet crystals .25 mm. in diameter arranged in parallel bands. The trapezohedron 211 is the dominant form modified by the dodecahedron. A soft plumose muscovite near the Victor mine contains 1 cm. garnet crystals with 110 and 211, the former dominant.

* *Am. Jour. Sci.* (4), 22, 217, 1906.

Epidote occurs as a secondary mineral in seams associated with black tourmaline.

Tourmaline.—At Rincon tourmaline occurs in a variety of colors—pink, blue, violet, green, colorless and black. The black tourmaline is found all through the pegmatites, but the colored varieties are confined to the pockets of the Victor vein. Only one habit of crystals was observed. Prismatic crystals of rounded triangular cross-section due to oscillatory combination of $11\bar{2}0$ and $01\bar{1}0$ with sometimes $10\bar{1}0$ as a line face are terminated at one end by the ditrigonal pyramid $12\bar{3}2$ (Fig. 6, *a*) and the trigonal pyramid $10\bar{1}1$, and at the other end by the pedion $000\bar{1}$ and often by small faces of the trigonal pyramid $01\bar{1}1$ (Fig. 6, *c*). The distribution

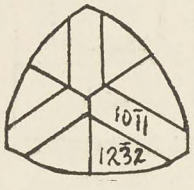

FIG. 6c.

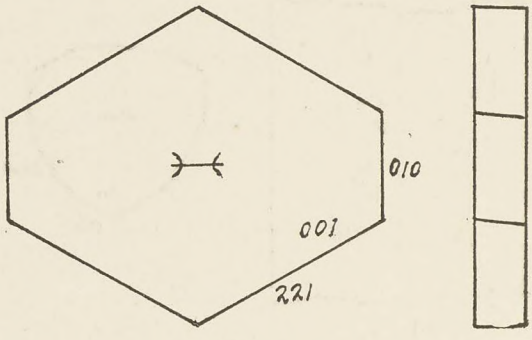

FIG. 7.

of color in these tourmalines is usually as given in Fig. 6, *b*. The central part is pink. Surrounding that on all sides is a pale green zone. The lower part of the crystal is deep blue often with a pale blue or colorless layer at the extreme end. A crystal broken transversely through the middle shows a central pink core with a green exterior zone. But some crystals are practically all blue or green, while others are mostly pink. Minute colorless prismatic crystals (achroite) occurring as a coating on quartz, albite and lepidolite probably represents a secondary deposit of tourmaline. A little rubellite in radiating columnar aggregates occurs in lepidolite as in the Stewart mine at Pala.

Stilbite.—At the Victor mine stilbite occurs as brown sheaf-like aggregates coating all the other minerals of the pockets. The individual crystals are 3 or 4 mm. long and have a rectangular cross-section with an apparent rhombic pyramidal termination.

Heulandite occurs sparingly associated with stilbite. The crystals are pale brown, sharp in angle and have the usual forms 010, 001, 201, $\bar{2}01$ and 110.

The zeolites are apparently very rare in granite-pegmatites, the only other locality known to the writer being San Piero, Elba.*

Laumontite.—Minute crystals of the common habit (110 and $\bar{2}01$) were found on a few specimens as a cavity lining. A very soft radiated white mineral from the Victor is apparently a laumontite pseudomorph after stilbite.

Muscovite.—The muscovite crystals found at the Mack mine are interesting because they have terminal faces and are often twinned. They are found in cavities which are lined with albite crystals and are often coated with red clay. The crystals are tabular, six-sided in outline, some being pseudohexagonal but most of them are somewhat elongated in the direction of the *b*-axis. They usually measure 2 to 3 cm. in diameter. The forms are 001, 010 and 221, the angle 001 $\wedge$ 010 being 90° and the angle 001 $\wedge$ 221 being 85° 36′ (meas. 86°). Fig. 7 represents a typical crystal with side elevation showing the monoclinic symmetry. On 001 the crystals show smaller parallel growths. Crystals are twinned according to the mica law. The twins are apparently made up of overlapping plates in twinning position. But such is not the case, for the composition face is perpendicular to the plates. The axial plane is normal to 010 and one arm of the percussion figure is parallel to 010. $2E$ for Na light was found to be 69° 26′.

Some large muscovite cleavages from the Victor mine are like Fig. 8, the longer striations representing gliding planes parallel to $\bar{2}05$ and the shorter ones, gliding planes parallel to $\bar{1}35$. In cross-section these cleavages are wedge-shaped.

Lepidolite occurs at the Victor mine near the center of the vein, but is not very prominent. It is fine to coarse scaly and is often intimately associated with albite crystals.

Two kinds of crystals are noted: (1) Pseudo-hexagonal crystals of tabular habit, (2) pseudo-rhombic crystals of prismatic habit united by twinning to form stellate groups. The pseudo-hexagonal tabular crystals are usually twins, but a single crystal is represented in Fig. 9. Here the forms are 001, $\bar{1}31$, 100 and 010. The angle 010 $\wedge$ $\bar{1}31$ was found to be $29\frac{1}{2}$°, the calculated being 30° 22′.

* Dana, "System of Mineralogy," 6 ed., 585, 1892.

The axial plane is parallel to 010, so it is a mica of the second class. Figure 11 is a crystal twinned according to the mica law, 001 being the composition face. In another type of twin, the crystal is made

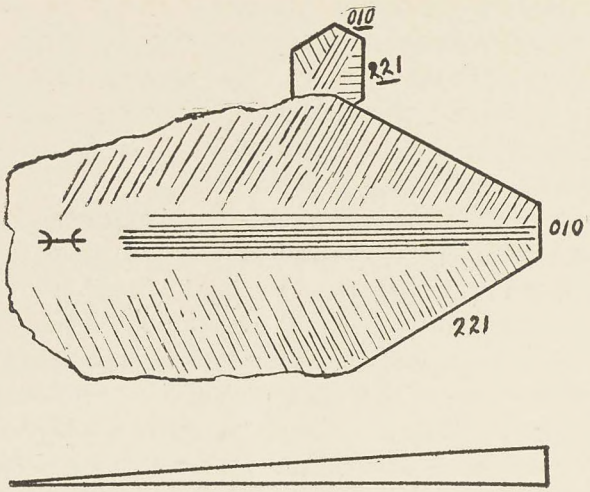

Fig. 8.

up of three individuals (Fig. 10) the composition face being perpendicular to 001.

Unique crystals of lepidolite are represented by Figs. 12*a*, and 12*b*. The habit is determined by $\bar{1}31$. The axial plane as well as the plane of symmetry is parallel to the long diagonal. Single crystals of this type occur, but they are rare. Most of the crystals

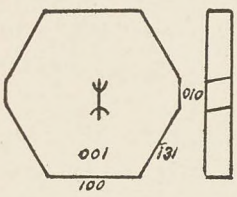

Fig. 9.

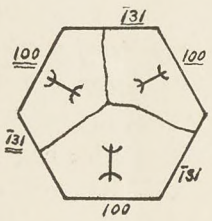

Fig. 10.

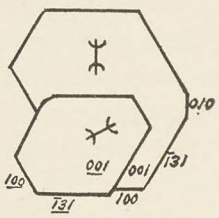

Fig. 11.

are twinned groups, according to the mica law. They consist of six single crystals. Examination of these crystals shows that they have as a common base a single cleavage, which, examined in polarized light, shows six rather confused sectors extinguishing in opposite parallel pairs. The obliquity of the $\bar{1}31$ faces to the base

is the reason that there are spaces between the upper parts of the crystals. This fact is brought out in Fig. 12*b*, which is an elevation of the two opposite crystals which have their *a*-axes horizontal.

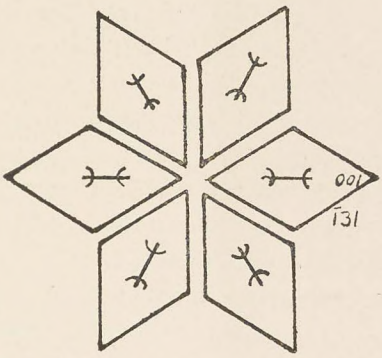

FIG. 12*a*.

These crystals often have 010 faces present, also 100 faces and occasionally both 010 and 100 are present.

Biotite was found in the Victor mine as thin dark brown inelastic cleavable plates about 3 cm. in diameter.

Cookeite.—This mineral occurs in the pegmatite veins of Maine and Connecticut, but is here described for the first time from San

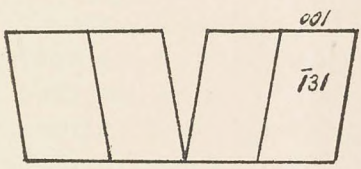

FIG. 12*b*.

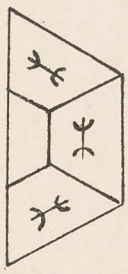

FIG. 13.

Diego Co. It was found in the pockets at the Victor mine coating quartz, lepidolite, orthoclase, albite and kunzite, and as the matrix of kunzite. It is clearly a secondary mineral—a pseudomorph of cookeite after kunzite was found. Cookeite is a micaceous mineral occurring in minute rosettes (not over 1 mm.) or in massive aggregates. The color varies from colorless to deep pink, a yellowish-

pink being very common. The blowpipe tests agree with those given for cookeite in Dana's "System." The soda fusion is bluish-green, indicating manganese. The crystals are half-hexagonal in outline and if complete would be made up of a central unaxial core with six biaxial sectors as in Fig. 13. The axial plane of the sectors is parallel to the hexagonal outline and the axial angle is rather small. This agrees with the description given by Penfield.*

Columbite.—Several small imperfect prismatic crystals were found in the Victor mine. The forms are 100, 210, 130, 103 and 133. There is distinct cleavage parallel to 100.

Amblygonite.—A few small specimens of white cleavable amblygonite were found at the Victor mine.

Apatite.—Pale dirty green thin to thick tabular crystals of apatite were found at a prospect near the Victor. The forms are 0001, 10$\bar{1}$0, 11$\bar{2}$1, 10$\bar{1}$2, 10$\bar{1}$1 and 31$\bar{4}$1.

Paragenesis of the Minerals of the Victor Vein.

With the exception of the zeolites the minerals are all characteristic species of granite-pegmatites. The minerals occur for the most part in lens-shaped pockets along the median line of the vein. According to Brögger and Harker the work of mineralizers in the formation of pegmatites is both constructive and destructive in nature. Orthoclase, albite, quartz, tourmaline (colored) and lepidolite form the walls of the pockets. They were probably formed simultaneously, for when two of them occur together it is almost impossible to tell which was formed first. The crystallization of these minerals probably represents the end of the constructive period. Many of the pockets contain clay. The above mentioned minerals are often coated with cookeite and zeolites. Besides the orthoclase crystals are often corroded. These results are probably due to destructive action of the mineralizers occasioned by fall in temperature. The kunzite is almost invariably found embedded in the clay of the pockets, but it hardly seems reasonable to regard it as a secondary mineral. One specimen in the University collection shows a kunzite crystal firmly attached to a lepidolite-albite matrix, projecting out in what was a cavity. The presence of kunzite in the clay is perhaps due to the fact that the crystals were attacked

* *Am. Jour. Sci.* (3), 45, 393, 1893.

by mineralizers on all sides and so fell from the walls into the bottom of the pockets. The kunzite crystals are usually much corroded and rounded. The pocket clay was probably formed from the feldspars and the cookeite, clearly a secondary mineral, may have been formed from either tourmaline, lepidolite or kunzite. The cookeite is often the matrix of kunzite and also of tourmaline. The zeolites were formed after the cookeite, perhaps by solutions at temperature little above the ordinary, after the gases were given off. Finally the hyalite was the last mineral to form as it occurs on stilbite in one specimen. It was formed from ordinary solutions as its presence on a freshly broken rock surface would indicate.

One specimen illustrating the above paragenesis deserves description. In the bottom of a pocket there was found just below a large quartz crystal a thin crust of the same outline which had evidently fallen from it. The inside smooth surface of this crust was pink cookeite, while the outside was stilbite. A few isolated stilbite crystals were also found inside the crust. Several crystals of very much corroded kunzite were firmly embedded in the crust and penetrated the inside surface.

STANFORD UNIVERSITY, CALIF.,
October, 1909.