L. Hess, of the Bureau of Mines, this pegmatite was worked for a time by Herman Reinhold, who claimed that he obtained gadolinite from the pegmatite in considerable quantity. The analysis shows that the mineral is not gadolinite but allanite. A careful test for beryllium was kindly made by J. J. Fahey, but none was found, thus proving the complete absence of gadolinite.

The pieces examined were of irregular shape with resinous luster and black color except for reddish-brown and pale yellow coatings or stains in a few places between the mineral and adjoining rock. Streak, pale gray.

A RECENT FIND OF BIXBYITE AND ASSOCIATED MINERALS IN THE THOMAS RANGE, UTAH

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INTRODUCTION

During early September of 1933 the writer was able to spend a week exploring the northern part of the Thomas Range in west-central Utah. The chief purpose of the trip was to locate if possible the old bixbyite locality where all the best specimens of that mineral have apparently originated. The exact location has never been very clear. It has been described as thirty-five miles south-west of Simpson,[1] and in the southern end of the Dugway Range.[2] Confusion has always arisen from the fact that "Dugway" is a term used locally to include two mountain ranges. The topographic map shows the Thomas and northerly-bordering Dugway Ranges as separated by the Dugway Road which cuts between them from east to west at a point approximately seventeen miles north of Topaz Mountain. It is possible that there may be an occurrence of bixbyite in the southern Dugway Range, but the writer believes that he has found the original locality in the north-east section of the Thomas Range. A day's exploration north of the Dugway Road failed to reveal anything of mineralogical interest.

LOCALITY AND OCCURRENCE

In its northern area the Thomas Range widens considerably to the east and west. Numerous ridges extend outward from the central body of the range and, together with their adjoining canyons,

[1] Penfield, S. L., and Foote, H. W., *Am. J. Sci.*, Vol. 4, pp. 105–110, 1897.

[2] Bixby, Maynard, A Catalogue of Utah Minerals and Localities 1916, p. 6.

form a veritable maze of hilly topography. The character of this region is the most barren imaginable, with very scant vegetation and no signs of water.

It was in the north-east portion of this area, perhaps three or four miles south of the Dugway Road, that several very interesting mineral occurrences were discovered. At one locality excellent specimens of bixbyite were found, and the writer has reason to believe that this coincides with the original locality of the late Maynard Bixby.

The occurrence of the bixbyite is limited to the southeastern extremity of a ridge which runs in a general north-south direction. This ridge is about 150 feet high and on its eastern slope shows an extensive exposure of the typical whitish-gray rhyolite. The bixbyite is confined further to the lower 20 or 30 feet of the ridge exposure. Associated minerals are topaz, garnet, beryl, hematite, and quartz.

Description of Minerals

Bixbyite

The bixbyite occurs as black crystals on topaz, on garnet, and in the rhyolite. Those of the former occurrence are usually larger than the others and more numerous. The bixbyite crystals tend to form in clusters near one end of a topaz crystal or else are found scattered along the prism. That the formation of the bixbyite followed very closely, indeed coincidently, with that of the topaz is indicated by the fact that the topaz often has been forced to make room for the later-forming mineral.

Bixbyite crystals on garnet occur indiscriminately; are generally quite small but numerous. Those in rhyolite occur in small cavities of the rock and are neither so large nor numerous as in either of the other occurrences.

Practically all the crystals are simple cubes with the exception of those which occur in a small area on the southerly tip of the ridge. Here the typical crystal is the cube modified by the tetragonal trisoctahedron $n(211)$. These crystals, associated with rough, opaque topaz, are very numerous but never larger than 3 or 4 mm. in diameter. One group of modified crystals was found to have the octahedron $o(111)$ present in addition to $n(211)$. So far as the writer has been able to learn, this is a new form for bixbyite.

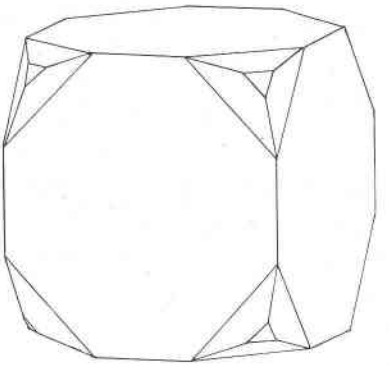

FIG. 1. Crystal of bixbyite with $a(100)$, $n(211)$, and $o(111)$.

Examples of interpenetration twinning on (111), as in fluorite, were found to be not unusual. Some of the bixbyite crystals proved to be quite large. Four or five individuals measured a full quarter-inch in diameter, and there are many more cubes of nearly equal size.

TOPAZ

Crystals of topaz are predominately of the gray, opaque type with rough and irregular surfaces. However, parts of these crystals are frequently transparent with crystal faces perfectly developed. This gradation of the opaque to the transparent in topaz is a striking feature of many crystals and clearly shows the opaque character as due to countless included quartz crystals of microscopic size. Individual quartz crystals of this type often can be distinguished with a lens in transparent portions of some topaz.

A few opaque crystals were found with smooth faces. One or two are perfectly developed and doubly terminated. A similar type of crystal has already been described from Topaz Mountain,[3] so that further description of these is unnecessary except for the fact that basal pinacoid (001) and brachydome (021) are both represented in addition to the simple form of prisms and pyramid. Although most of these crystals were picked up loose, it was evident that they had weathered out of near-by masses of a fine-grained rhyolitic tuff. This coincides with Patton's description of the Topaz Mountain occurrence.[4]

[3] Patton, H. B., *Bull. Geol. Soc. Am.*, Vol. **19**, pp. 177–192 1908.
[4] Patton, H. B., *loc. cit.*

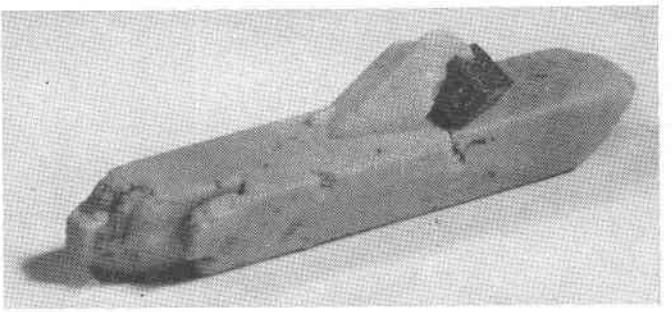

Fig. 2. Bixbyite crystal on smooth, opaque topaz.

Some of the crystals of opaque topaz attain considerable size. Crystals nearly two inches in length are not uncommon from this locality, and one or two measured well over two inches. The transparent crystals are generally small, but several were discovered here which may surpass in size any of like type yet found in the Thomas Range. One crystal, an inch in length, measures one-third by one-half inch across the *a* and *b* axes respectively. It is nearly flawless.

Many transparent crystals show a dull coating on certain terminal faces, which appears to be due to etching. It is remarkable that with some faces dulled in this way, other adjoining faces, apparently equally exposed, fail to show any etching effects whatsoever. Some topaz, opaque and transparent, tends towards a dark color. This seems to be due to the presence of included plates of hematite.

Garnet

Garnet, which is plentiful here in cavities of the rhyolite, usually takes the form of rounded, partially-disintegrated crystal fragments. It is rarely that a complete crystal of trapezohedral form is found. Crystals and crystal fragments alike are apt to be coated with a sprinkling of bixbyite.

The composition of this garnet, as determined by Penfield and Foote,[5] seems to be an alteration now constituting a mixture of bixbyite, topaz, and quartz. Before alteration the composition was probably that of spessartite.

The size of the garnets varies from an eighth of an inch to a full inch in diameter. The color is a dark gray. Some of the crystals are found implanted on topaz, indicating a later genesis.

[5] Penfield, S. L., and Foote, H. W., *loc. cit.*

Topaz-Garnet Epigrowth

The surfaces of a few garnets were found partially covered with very small, transparent topaz crystals. The latter, evidently of later origin than other topaz of this locality, form typically a closely-woven, reticulated network of crystals. On closer examination these crystals are seen to be definitely oriented on the garnet.

This same epigrowth of topaz on garnet, probably of identical locality, has been described by Cahn[6] and by Goldschmidt and Schröder.[7] It was found that the crystal forms of the decomposed garnet could be reconstructed by measuring the crystallographic relations of the topaz. The general interpretation was that the topaz crystals had formed practically simultaneously with the garnet, and in orientation with each garnet crystal. Later the garnet suffered partial disintegration through some agent which left the topaz unaffected.

One specimen collected by the writer illustrates with unusual lucidity the crystallographic relations of the two minerals in this epigrowth. In this specimen four pairs of topaz crystals radiate symmetrically from a point which represents the termination of the crystallographic axis of the underlying garnet. Each pair indicates between them an edge of the $n(211)$ garnet face and to which they are nearly parallel. A third topaz crystal, completing what is practically an equilateral triangle on the $n(211)$ face, lies parallel to an edge of the $o(111)$ and $n(211)$ garnet faces. These three topaz crystals typify through their positions the three directions taken by all topaz on each garnet $n(211)$ face; furthermore the brachypinacoids $b(010)$ of all three crystals are parallel and represent a plane surface which coincides with the $n(211)$ face of the garnet. The relationships between the two minerals as shown in this specimen are of added interest when one realizes that the crystal form of the garnet is completely missing, and in its place nothing remains but an irregular, rounded surface.

Beryl

Only two specimens were found of the red beryl which has already been described from the Thomas Range.[8] One crystal was picked up loose; a second was found adhering to rough, opaque topaz. Both crystals are examples of the simple hexagonal prism terminated by the base. They are flattened parallel to the base

[6] Cahn, Lazard, *Beitr. f. Kryst. Min.*, Vol. **2**, pp. 7–9, 1919.

[7] Goldschmidt, V., and Schröder, R., *ibid.*, pp. 11–16.

[8] Hillebrand, W. F., *Am. J. Sci.*, Vol. **19**, pp. 330–331, 1905.

and consequently of tabular shape. The color is a pale cherry-red. Both crystals measure an eighth of an inch across the base and are about one-third as thick.

In general it should be noted that practically all the specimens found at this locality were picked up loose in the talus or scant, rocky soil. It indicates not only the thoroughness of the weathering in this region, but also leads one to believe that this locality has been visited seldom, if ever, by collectors in recent years.

Blasting was tried in several places but proved, with one exception, to be quite fruitless. A few wine-colored topaz crystals were obtained after one blast, and bixbyite was present on most of these as small cubes of a very brilliant luster.

An Occurrence of Rare-Colored Topaz

Less than a mile eastward from the bixbyite locality, a second ridge exposure of whitish-gray rhyolite was discovered. Rough, opaque topaz crystals are very plentiful here, but practically no bixbyite. A majority of the topaz possess a pale rose to rose-red color along each side of the crystal. A few small, transparent crystals were found to be rose-tinted throughout, and the beauty of these specimens, combined with the rarity of this color in topaz, makes them of particular interest.

Minute, black crystals of two distinct types were observed to be present on surfaces of many topaz from this locality. Some of these crystals appear to be of rhombohedral shape, and it is possible that they are hematite. Others are slender, vertically-striated prisms. Professor Charles Palache of Harvard University has kindly identified the crystals as pseudobrookite. This is the second reported occurrence of pseudobrookite in the Thomas Range, following Palache's earlier description in the preceding issue of this Journal.

The fact that both the rose color of topaz and presence of pseudobrookite are unique factors of this mineral occurrence, leads one to suppose that the rose color in the topaz may be due to the presence of titanium. It should be noted also that this rose color is not lost on exposure to light, as it is in the wine-colored topaz, for all the specimens described above were found weathered out of the rhyolite and fully exposed to the elements.

Acknowledgment

The writer wishes to express his indebtedness to Professor A. H. Phillips of Princeton University for invaluable assistance rendered throughout the preparation of the article.