

any other part of the crystal and the entire surface gave a suggestion of the primary shape shown in Fig. 2. The tests were not conclusive, but suggested that the quartz molecule had a very much greater attraction for other quartz molecules along certain planes than others.

#### CONCLUSIONS

Primary skeleton quartz crystals seem to show that the quartz molecule has a greater attraction along three lines at  $60^\circ$  to one another than in any other direction.

Etch figures on polished surfaces of pure bipyramidal quartz crystals from Spring Creek, Colorado, seem to show the same molecular attractions within the quartz as do the skeleton crystals.

These lines of greatest molecular attraction correspond to the usual crystallographic axes and it would seem that these hypothetical axes express the directions of greatest molecular attraction.

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## TOPAZ AND ASSOCIATED MINERALS FROM THE EINSTEIN SILVER MINE, MADISON COUNTY, MISSOURI<sup>1</sup>

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#### INTRODUCTION

The Einstein Silver Mine of southeastern Missouri was visited by one of the writers (Clarence S. Ross) in company with Dr. W. S. Bayley and several graduate students in geology from the University of Illinois in the spring of 1917. The old Einstein Silver Mine, which is located on the banks of the St. Francois River, nine miles west of Fredericktown, Madison County, Missouri, contains a group of minerals unknown elsewhere in the Mississippi valley region.

The following notes on the mine are given by Buehler<sup>2</sup>:

"Systematic prospecting was begun in 1877 and as a result a quartz vein was opened. . . . After producing fifty tons of lead and three thousand ounces of silver

<sup>1</sup> Published by permission of the Director of the U. S. Geological Survey.

<sup>2</sup> Buehler, H. A., Biannual report of the State Geologist of Missouri, pp. 97, 98 (1919).

the property was shut down. . . . The Einstein Mine is located near the southern end of the granite area which extends southward from Doe Run for a distance of about fifteen miles. The country rock is a coarse grained red granite which is cut by diabase dikes and veins of quartz. . . . Three distinct veins of quartz have been opened up and developments started on four others. The veins vary from a few inches to five feet in width, the average being about two feet. . . .

"The locality is unique in furnishing a number of minerals found nowhere else in the State. Tungsten in the form of hübnerite is scattered through the quartz from the size of a pin head to massive bunches weighing one hundred pounds. Pyrite and a dark lithia mica (zinnwaldite) usually appear where the hübnerite is bunched."

In 1888 Erasmus Haworth published a paper entitled "A Contribution to the Archean Geology of Missouri,"<sup>3</sup> in which topaz and its associated minerals are admirably described as follows:

". . . The vein itself was filled with quartz, argentiferous galena, fluorite, lepidolite (more correctly described as zinnwaldite), wolframite, and probably other minerals. The wall-rock was originally granite. At present, however, it consists of quartz imbedded in a fine-grained mixture of mica scales and traces of iron oxide, leucoxene, beautiful little zircon crystals and probably other materials. Scattered through this mass in varying proportions are the minerals fluorite and topaz.

We evidently have here the results of a fumerole action, recalling in some respects the conditions around the tin mines of Cornwall, England, of Zinnwald in Bohemia, and those of other places. The resemblances consist in the granite wall-rock being decomposed for a few feet on each side of the vein, and the occurrence of topaz, wolframite, lepidolite and fluorite, minerals which are associated with tin ores in other places. But so far as now known there is a total absence of cassiterite, as well as of tourmaline, and other minerals—excepting those just given—which always accompany tin deposits.

TOPAZ.—In all the thin sections examined from the wall-rock of the vein just described a considerable quantity of a mineral thought to be topaz was found. It does not have a regular crystalline form, but in many cases the direction of the crystallographic axes could be determined. Its index of refraction, as shown by its apparent thickness, its parallel extinction, and its polarization colors strongly implied that the mineral in question was topaz. . . . A blow-pipe examination with the salt of phosphorus proved it to be a silicate. There can be little doubt, therefore, that the mineral is topaz."

Recently some of the specimens secured in 1917 were re-examined and one of them was found to contain an abundance of a fine-grained mineral that had the optical properties of topaz. As it is not generally known that topaz occurs in this region, it seemed wise to definitely establish the identity of the material, and so it was analyzed by the junior author (E. P. Henderson).

<sup>3</sup> Haworth, Erasmus, *Am. Geol.*, **1**, 295 (1888).

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The minerals that have been reported from the vein itself are quartz, fluorite, argentiferous galena, pyrite, sphalerite, hübnerite and scheelite,<sup>4</sup> the latter intimately intergrown with hübnerite. The wall rock on either side of the vein has been profoundly altered and the minerals topaz, quartz, fluorite, argentiferous galena, pyrite, sphalerite, hübnerite and scheelite have developed through the replacement of granite.

The feldspar in the granite of the wall rock has been completely replaced by muscovite and the quartz partly replaced so that isolated island-like areas are all that remain of large quartz crystals. The fluorite (variety chlorophane) is colorless to blue, and on heating glows with a green color that soon changes to purple.

PHYSICAL AND CHEMICAL PROPERTIES

PARTIAL ANALYSIS OF TOPAZ FROM EINSTEIN MINE, TOPAZ OF IDEAL COMPOSITION, AND TOPAZ FROM TRUMBULL, CONN.

	A	B	C
SiO <sub>2</sub>	32.65	33.3	32.38
Al <sub>2</sub> O <sub>3</sub>	54.67	56.5	55.32
Fe <sub>2</sub> O <sub>3</sub>	1.78	—	—
F	n.d.	17.6	16.2
Total	89.10	107.4 <sup>a</sup>	104.82 <sup>a</sup>

<sup>a</sup> Deduct oxygen equivalent of the fluorine (= 6 to 7 per cent).

A. Topaz from Einstein Mine, nine miles west of Fredericktown, Mo. E. P. Henderson, analyst.

B. Ideal composition of topaz, with aluminum given as oxide.

C. Topaz from Trumbull, Conn.<sup>5</sup>

Fluorine was not determined quantitatively but was found to be present in quantity as an essential part of the mineral.

The topaz has the following optical properties. The indices of refraction are  $a = 1.609$ ,  $\beta = 1.614$ ,  $\gamma = 1.618$ ;  $a - \gamma = 0.09$ , optical character (+),  $2V = 66^\circ$ ,  $2E = 120^\circ$ ,  $\rho > \nu$ .

<sup>4</sup> Hess, Frank L., Personal communication. Material collected by Ross, examined by Hess.

<sup>5</sup> Dana, System of Mineralogy, p. 495.