



FIGURE 1.
EUBHEDRAL CRYSTAL OF BIS-
BEEITE, SHOWING OPTICAL
ORIENTATION

prove the identity of the mineral in question with the original bisbeeite.⁴ The axial colors of the bisbeeite are as follows:⁵ γ = rather deep blue, β = pale bluish green, α = neutral. The absorption scheme is $\gamma > \beta > \alpha$. The bisbeeite is probably optically positive.

MORPHOLOGY: The ends of some of the minute acicular crystals project into cavities; they for the most part have indefinite terminations, but a few have a form similar to that shown in Figure 1. The forms present are the three pinacoids: (100), (010), and (001). The optical orientation is: $a = \alpha$, $b = \beta$, and $c = \gamma$. If the observations are correct bisbeeite is orthorhombic in crystallization.

THE BELLEVILLE COPPER-MINE

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The Schuyler Copper-mine at North Arlington, New Jersey, is believed to be the oldest in the United States. It is situated on property secured by Captain William Sanford of the British Army by a patent, issued on July 4th, 1668, conveying to him about ten thousand acres of meadow-land and five thousand three hundred acres of the higher ground lying between the Hackensack and the Passaic Rivers. Nathaniel Kingsland, sergeant-major of the island of Barbados, later became interested in this grant, and from him the eastern half of the town of Lyndhurst takes its name. Sometime about the year 1712 or 1713 the discovery that copper existed in the rock appears to have been made by Arent Schuyler (1662-

⁴ Larsen's (*U. S. Geol. Surv., Bull.* 679, 48, 1921) values for the indices of refraction of bisbeeite are: $a = 1.615$, $\beta = 1.625$, $\gamma = 1.71$, all ± 0.01 . It is doubtful whether he worked with the original mineral.

⁵ γ , β , and α are axial directions of the index ellipsoid and n_γ , n_β , and n_α , the values of the indices of refraction for these directions.

1732) who had purchased the tract from Kingsland. The exact date when the deposit began to be worked is not known, but Robert Hunter, Governor of the united colonies of New York and New Jersey, writing from New York in November, 1715, to the Lords of Trade in Great Britain, said: "There being a Copper Mine here brought to perfection as you may find by the Custom House books at Bristol, where there was imported from this place about a Tonn in the Month of July or August last, of which Copper farthings may be coyned."¹ In April, 1721, there were one hundred and ten casks of ore from this mine shipped from New York to Holland. This shipment caused much concern to the Lords of Trade, who suggested that the matter should be laid before Parliament in order that such shipments "be prevented by some act to be passed for that purpose." Nine years later, so leisurely did they proceed in those days, the Governor, John Montgomerie, had a conference with Col. John Schuyler regarding such shipments and found him unwilling to aid in the matter beyond promising that when his ships arrived in England with the ore the English Copper Company should have first sight of it.² In August, 1734, the New Jersey legislature imposed a duty of forty shillings per ton on all copper exported from the province not directly to Great Britain. Strangely enough this measure was opposed by the English Copper Smelters because it was found that the law was evaded by shipping the ore to New York and thence to England or other countries. The Bristol traders feared that imposing "such a Duty may be a Great discouragement to the seeking after the Oare the same being brought home to be refined and manufactured and if discouraged by a Tax abroad it will consequently lessen your Majestys Revenue at Home, the Copper and Brass Manufacturers of this Kingdom and the Trade and Navigation to the American Plantations."³

For many years the mine yielded large quantities of rich ore, but in time the workings reached a depth beyond which hand and horse-power could not keep it clear of water. When first worked the yield averaged about one hundred tons per annum and the mine returned a substantial profit to its owners, and it is stated that from the books of the discoverer, it appears that before the

¹ *Documents relating to Colonial history of New Jersey*, 1 ser., 4, p. 222.

² *New Jersey Archives*, 5, pp. 7, 9, 267.

³ *Ibid.*, 5, p. 377.

year 1731 he had shipped 6933 casks making about 1386 tons to the Bristol Copper and Brass Works. Writing about the year 1750 William Douglass, in his *Account of the British Settlements in North America*,⁴ says "Schuyler's copper ore is from a Mine in Jerseys but exported from New York. . . . The Cartage to Hudson's River is short, and their first Agreement with the Miner, was to allow him one-third of Ore for raising and laying it above Ground; it was done up in quarter Barrels, whereof six made a Tun. The richness of this Copper Mine made so much Noise in the World, that a few years since, to engross this Ore for the benefit of Great Britain, it was by Act of Parliament enumerated; but lately it has not been Wrought and Exported, as appears by the quarterly accounts of the Custom-House of New York."

In 1749 the mine was visited by Benjamin Franklin,⁵ and on February 13th of the following year he wrote to Jared Eliot from Philadelphia: "I know of but one valuable copper mine in this country, which is that of Schuyler's in the Jerseys. This yields good copper and has turned out vast wealth to the owners. I was at it last fall, but they were not then at work. The water is grown too hard for them, and they waited for a fire-engine from England to drain their pits. I suppose they will have that at work next summer; it costs them one thousand pounds sterling." The pumping engine ordered from England in 1748 or 1749 was not shipped to the mine until about four years later, in September, 1753.

In 1761 the mine was leased by a new company, with Josiah Hornblower, the young engineer who brought over the pumping-engine and set it up, as their mine expert. The engine-house was soon after burnt down but rebuilt, and the mine worked for four years with, it is said, "great advantage and profit." In 1765 a workman, who had been dismissed for some reason, in revenge set fire to the engine-house in consequence of which the works were discontinued for a number of years. It was not till 1793 that another company was formed which undertook the work with a great show of energy. Beyond clearing out the rubbish which choked the drifts and levels and getting the old engine once more into working order, they appear to have confined their

⁴ *Account of the British Settlements in North America*, 2, pp. 257-258, Boston, 1751.

⁵ Writings, ed. A. H. Smith, 3, p. 1, 1905.

energies to forming a company and selling stock. A prospectus issued by them stated that "The ore of the Schuyler's mine yields, in each hundred pounds of copper, from four to seven ounces of silver, and like most copper ores, a small portion of gold," and they add, "At the time when pure copper was sold in England at seventy-five pounds sterling per ton, the ore of Schuyler's mine was shipped for England at New-York at seventy pounds sterling per ton." If the statement were true about the amount of silver found in the mine it would have been much more profitable to have worked the mine for silver alone, as such a production of that metal would equal the output of some of the most productive silver mines of the world.

During the early years of the nineteenth century it is believed that the mine was worked spasmodically, but for six years, from 1859 to 1865, it is said that upwards of two hundred workmen were employed in the mine and mills. In 1900 an expensive mill and reduction plant were set up, but short experimental runs proved that it was not adapted to the ore, and since then the mine has lain idle.

Kümmel, in his annual report to the Geological Survey in 1897, speaking of this mine says: "It must be confessed that the outlook for valuable copper deposits in these rocks is not encouraging. Nothing was observed in the course of this survey to warrant the inference that in the future prospecting for copper would be more remunerative than in the past."

Forty-two shafts are said to have been sunk on the property, but only one, called the Victoria shaft, has been kept open. This main shaft is said to be about 350 feet deep, but all is mud and rubbish below the 240-foot level and difficult of access. The old Cornish pump, considered a wonderful piece of mechanism in its day, is believed to be still in position at the bottom of the shaft buried in the mud. Three drifts from the bottom of the shaft are said to exist, one towards the northwest about 180 feet long, one to the southwest also 180 feet long, and the third running south for about 210 feet. There are also three drain tunnels, one of which drains the mine to the 100-foot level. Two inclines have been run in from the face of the bluff overlooking the meadows. One of these is 220 feet long and the other 80 feet.

The ore found at Arlington is chalcocite or copper glance with much secondary chrysocolla and smaller amounts of malachite.

Small amounts of azurite and cuprite have been found, along with occasional particles of native copper.

The ore occurs in unaltered grey or nearly white arkose sandstone in greater part adjacent to dikes and intrusive sheets of trap although no dikes or sheets of this rock appear at the surface. There are two layers of this arkose sandstone, the lower one about ten feet thick and the upper one about twelve feet separated by about one foot of shale. The copper ores have originated from hot copper solutions, probably of magmatic origin, deriving both their heat and their copper salts from the underlying Palisades trap sill and its offshoots. "The deposition of chalcocite," says Prof. Volney Lewis,⁶ by the heated waters near the intrusive, and of native copper with minor amounts of glance in the more remote, cooler regions, has in both cases doubtless been chiefly the result of cooling, supplemented perhaps in part by reactions with the calcite of the shales. The conditions of considerable accumulation have been supplied by some relatively impervious member, a dense shale or a trap sheet, which has sufficiently impeded the movements of the uprising solutions to permit considerable cooling, and, therefore, extensive deposits, and also to allow time for any possible reactions with the calcite and for leaching out the ferric iron, in part, by the acid waters."

AN UNUSUAL DIAMOND CRYSTAL

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A short time ago Professor H. F. Cleland, of Williams College, sent to the Mineralogical laboratory a portion of a diamond crystal which proved to be of considerable interest. The specimen was hollow, and it was desired to determine whether or not the cavity had originally contained another diamond. Not only was this cavity unusual, but in addition two faces were found which represent a new form for the diamond.

The portion submitted for examination had been sawed from a larger stone, concerning which no information is available. As shown by the drawing (Fig. 1), this portion consisted of one half of an octahedron, and was about 5 mm. across. The octahedron was the predominant form, together with a well developed hexoctahedron (541), and in addition there were two small hexoctahedron faces which gave the indices (975), and which are desig-

⁶ Copper deposits of the New Jersey Triassic, *Econ. Geology*, 2, p. 257.