

NOTES ON A NEW OCCURRENCE OF COPPER ARSENATES
AND ASSOCIATED MINERALS, IN UTAH.*

BY RICHARD PEARCE.

My attention has been recently called to a number of rare and beautiful minerals occurring in the Mammoth mine, Tintic district, Utah, and found in the ore shipments from this mine to the Boston and Colorado Smelting Works at Argo. The series is in many respects similar to that from the neighboring American Eagle mine, announced by myself before this Society in April, 1884,† and subsequently further investigated by Dr. W. F. Hillebrand,‡ though the two occurrences are entirely distinct, and the present one contains several species not found in the other.

Enargite is the mother mineral of most of the group, and the paragenetic relations are clearly shown in many of the specimens obtained. The list of recognized species embraces enargite, olivenite, conichalcite, clinoclasite, brochantite, pharmacosiderite, malachite, azurite, and several other as yet imperfectly determined ones to be mentioned below.

The identification of the newly recognized minerals rests upon outward resemblances and upon the data to be given, which, though imperfect, are thought to be sufficient to attest the correctness of the determination of several species either new or of very rare occurrence in this country.

1. *Clinoclasite.*

Occurs, associated with quartz, barite, azurite, malachite, conichalcite and enargite, in groups of stout crystals,

* See also communication at December meeting, p. 150.

† Proc. C. S. S. Vol. I, p. 75.

‡ *Ibid.*, p. 112.

with polished blackish blue outer surface, and characteristic bluish green streak. Sp. Gr. 4.36, the maximum given by Dana for the species.

Two analyses yielded the following:

	I.	II.
As ₂ O ₃	29.36	28.85
CuO	61.68	61.22
H ₂ O	7.31	7.27

Small quantities of Fe₂O₃ and Al₂O₃ were not determined.

2. *Brochantite*.

This mineral occurs sparingly in beautiful, minute, emerald green crystals, with clinoclase and pharmacosiderite. One small crystal gave

CuO	H ₂ O	SO ₃
68.7	12.44	undetermined.

It seems possible that the variety of brochantite called *warringtonite* exists in one of the specimens.

3. *Pharmacosiderite*.

Appears in small yellow cubes, without any tetrahedral modifications as far as observed. A chemical examination of 30 milligrams gave As₂O₃ 31.08 per cent. This is about 9.00 per cent. too low, but the result is probably explained by the amount of inseparable foreign matter in the material tested. In hardness the mineral agrees with pharmacosiderite. The color is somewhat different from any I have before seen in this mineral, some of the crystals having a honey yellow shade. It occurs with clinoclase and other of the species above mentioned.

4. *Tyrolite?*

A mineral found as a thin coating on quartz with enargite and clinoclase, has a bright dark green color, with radiate scaly structure. H. about 2. - 2.5. It decrepitates violently when heated. 79 milligrams of the mineral gave:

As ₂ O ₅	27.66
CuO	34.00
Fe ₂ O ₃ (Al ₂ O ₃)	4.05
CaO figured as CaCO ₃	10.03
H ₂ O and insol. (by dif.)	24.26
SO ₃	traces
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	100.00

The presence of CO₂ was not demonstrated beyond a doubt.

Another specimen shows small tabular, flexible, green crystals, lining a cavity in quartz. H. 1-2. Only 28 milligrams could be obtained for analysis without destroying the entire specimen. I found :

		Tyrolite, Dana.
As ₂ O ₅	27.52	25.01
CuO	37.33	43.88
CaO as CaCO ₃	16.00	13.65
H ₂ O by difference,	19.15	17.46

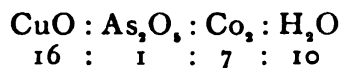
These analyses must be taken for what they are worth. The agreement in arsenic acid and copper oxide seems to indicate that the two substances tested are the same, and the approximate agreement with tyrolite, together with similarity in physical characters, leads me to believe that this rare mineral is present in this series of copper arsenates.

5. *Alteration of Malachite.*

Being somewhat suspicious that the malachite accompanying these arsenates from the Mammoth mine might be found to contain some arsenic acid, I selected a specimen for examination which had all the appearance of malachite and was associated with clinoclasite. 108 milligrams were carefully freed from all foreign matter and found to contain :

CuO	60.50
As ₂ O ₅	11.49
Fe ₂ O ₃ (Al ₂ O ₃)	4.25
CO ₂ .H ₂ O (by difference)	23.76
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	100.00

I had at first thought that the substance might be malachite in process of change to conichalcite, but the entire absence of lime did not confirm this theory. Regarding the ferric-oxide, etc., as accidental impurities and figuring the CuO as 64.75, the substance is found to have very nearly the following atomic ratio :



It would then appear possible if not probable that arsenic acid is capable of being substituted for carbonic acid in malachite. I hope an opportunity will present itself at an early day to enable me to confirm this by an examination of larger quantities of pure material.