ART. XXXVIII.—*On the New Species Melanochalcite and Keweenawite. With Notes on some other known species;* by GEORGE A. KOENIG.

1. *Melanochalcite.*

FOR the material of this investigation I am indebted to Captain James Hoatson, of Calumet. I received it early in January of 1902, and informed that gentleman—about January 17th—that I had much reason to distinguish the black mineral as a new mineral species, for which I proposed the name *melanochalcite* (from μέλας and χαλκός).

Occurrence.—The material comes from the exploration shaft of the Calumet and Arizona Copper Mining Company, near Bisbee, Arizona. I am informed by Captain Hoatson that these specimens represent the character of the ore at a depth of 800 feet. All the mines in that district exhibit oxidized ores to a very considerable depth. Sulphides are rare. I had examined and assayed a number of samples for Captain Hoatson from time to time as the sinking of the shaft proceeded; all oxide ores, and of exceptional richness. No samples assayed under 10 per cent copper. Cuprite was always preponderating, sometimes mixed with much hematite; say, for instance, 30 per cent of the former to 70 per cent of the latter, as an extreme. Malachite and chrysocolla appeared sparingly; no azurite; whilst at the Copper Queen Mine, of the same belt, the silicate and the carbonates are in the foreground. The material under consideration in this paper differs from that of the upper shaft. The material before me presents hard spheroidal nodules, cemented together by a soft, brown-red, clayey material, easily removable. The nodules' nucleus is formed by granular cuprite, with occasional druses, the latter lined with octahedral crystals. This kernel is surrounded by a zone of pitchy-black mineral, a few millimeters in thickness. Upon this follows a banded green zone of chrysocolla and malachite. Thereupon follows white, or transparent, quartz. Within the quartz are smaller cuprite kernels, each with its aureole of black and green. Here the black material is thicker, but less pure as a whole. The purest substance is always thin, lying close to the cuprite. It passes into deep olive green; then light olive-green into the pure green of chrysocolla, or malachite. Thus the fracture-surface of a nodule is of striking beauty. The one before me, which served as model for the description, has an average diameter of 120 millimeters. The kernel is not centric, and rather oblong than circular. The black, green and white parts are massed chiefly on one side.

This material reminded me of the German "Kupferpecherz," which has been declared by eminent authorities as a mineral mixture of various bodies—chiefly chrysocolla and limonite. Dana places it under chrysocolla. I have analyzed such material coming from the Old Dominion Mine, Arizona, of a brown-black color. It was more the esthetic beauty of the present material which induced me to enter into its study, than the expectation of finding new facts. Absence of definite crystalline form is ever apt to call up a prejudice against the homogeneity or chemical integrity of bodies. In the present instance, additional reluctance was caused by thinness of the black zone. But since there was plenty of material, the question of obtaining a sufficient quantity of satisfactory substance could be answered by care and patience.

Physical Examination.—I picked out successively, and from different nodules, three portions of material—A, B, C. The sequence of the letters denotes the degree of scrutiny employed. "A" was intended for preliminary work, "B" for chemical orientation, and "C" for the final trial. At the beginning the chief care was the rejection of either red or green particles. But it was quickly discerned that among the dark material there was a lustrous and a dull portion; a banded and a bandless part. High luster and absence of band-structure go together; dullness and banding are yoked. Sample "A" was tainted somewhat by red, by green and by dull particles. Sample "B" was only contaminated by dull parts; but "C" was picked over several times, and contained only brilliantly-black material. This was time-consuming. It will be seen, however, from the analyses that the blemishes were rare even in "A" and "B." The black mineral is fairly hard—about 4; but it is exceedingly brittle. The cause of this brittleness lies, probably, in numerous microscopic fissures. As support for this opinion, I mention the long time required for the ceasing of air bubbles to rise, when the mineral was placed under water (specific gravity determination). And also the failure to obtain a thin plate by grinding; the plate going to small pieces long before translucence was reached. When the mineral is ground in a mortar it shows the disagreeable property of "smearing." The fine powder is coffee-brown in color. Some of the finest dust from sample "C," which had stuck to the mortar, was brushed upon a glass slide, imbedded in Canada balsam and examined under the microscope. It proved to be translucent, letting through yellow-brown light, one particle exactly as the other. The mineralogic uniformity and singleness of this material ("C") is undoubtable. In polarized light these dust particles behaved like an amorphous, or isotropic, body. The specific gravity was found to be

$\frac{1{\cdot}5972}{0{\cdot}3857} = 4{\cdot}141$ at 21 C. (material "C"). This number is rather under than above the true weight, because I wished to avoid boiling, in order not to interfere with the water-percentage of the material. To even up matters, the water used was saturated with air at 21 C. for both weighings.

Chemical Examination.—B. B. In closed tube the substance looses water and CO_2 and the coffee-brown powder turns to brown black. With the fluxes only copper reaction, except with microcosmic salt, when a fine skeleton of SiO_2 appears in a blue glass. The mineral is readily decomposed by HCl of all concentrations, even when in coarse fragments. If such a fragment be placed in 3 per cent HCl, and one observes with a pocket lens, one sees the margins of the splinter turn white. The white zone widens steadily, until nothing but a white mass remains, which occupies the entire space of the original black substance. And yet the percentage of SiO_2 is not quite 10. While this dissolution is progressing one sees a steady spray arise of minute bubbles of CO_2, very different from the big air bubbles arising from the microscopic capillary fissures. I consider this behavior as the essential foundation of my hypothesis regarding the constitution of the molecules of this mineral—to wit: *SiO_2 and CO_2 are simultaneously liberated*, whilst CuO and H_2O pass into the solution. The resultant SiO_2 is what I would call semigelatinous—not colorless and transparent, but white and translucent. It is readily dissolved by the water solution of NaHO. There is no cuprous chloride formed. The copper is altogether cupric.

Material "A"—preliminary analysis. Weight of substance taken, 0·5361 gr.

0·0671 loss by ignition.
0·0532 SiO_2
0·0010 Fe_2O_3
0·4188 Cu_2S

The sulphide was dissolved and electrolyzed, yielding 0·3277 Cu=0·4107 CuO, to which must be added 0·00015 CuO, obtained from the electrolyte by H_2S. Total, 0·4122 CuO.

In percentage:

$$\begin{array}{lr} CuO & = 76{\cdot}72 \\ SiO_2 & = 9{\cdot}91 \\ \left.\begin{array}{l} H_2O \\ CO_2 \end{array}\right\} & = 12{\cdot}52 \\ Fe_2O_3 & = 0{\cdot}19 \\ \hline & 99{\cdot}34 \end{array}$$

Material "B." 0·5658 gr. The tenacity for water at increasing temperature was tested by exposing the powder, for two hours each, at the following temperatures:

0·0092	loss at	88 C.
0·0142	"	110 C.
0·0082	"	160 C.
0·0128	"	210 C.
0·0444		
0·0451	loss at red heat.	
0·0895	total loss.	

CO_2 was not separately determined in this sample; but from the determinations in "C," when H_2O and CO_2 are nearly alike, the inference may be drawn that all the water is expelled at 210 C.

0·0500 SiO_2; 0·3415 Cu+0·0082 CuO from electrolyte by H_2S, 0·0008 Fe_2O_3.

$CuO = 76{\cdot}46$

$SiO_2 = 8{\cdot}83$

$\left.\begin{array}{l}CO_2\\ H_2O\end{array}\right\} = 14{\cdot}20$

$Fe_2O_3 = 0{\cdot}14$

99·63

Material "C"—This having been proved irreproachable material, the analysis was made with great care. CO_2 and water were determined as follows: 0·5260 gr. of the fine powder was placed in a porcelain boat and the latter heated in a combustion tube to redness, whilst a slow current of perfectly dried and purified air passed through the tube. An "U" calcium chloride tube received the water and a Geissler Potash bulb received the CO_2. The increase of weight in the former was 0·0407 gr.; in the latter, 0·0378 gr., a total of 0·0785 gram. At the same time the weight in the boat decreased by 0·0766 gram. Hence there is here an error of 0·0019 gr., which may be evenly distributed between H_2O and CO_2, or may even be neglected altogether without affecting the result sensibly. The copper was precipitated electrolytically, and in this case H_2S found no residue of copper in the electrolyte. The latter being thereupon rendered ammoniacal, a flocculent precipitate fell, which, after filtering and ignition, showed by its color that it did not consist of iron oxide alone. It was found to be $ZnO+Fe_2O_3$. I had overlooked the zinc in the other analyses.

The percentages are :

$$
\begin{array}{lrll}
 & & & \text{Molecules.} \\
CuO = & 76{\cdot}88 & : 79 = & 0{\cdot}96583 \\
SiO_2 = & 7{\cdot}80 & : 60 = & \left.\begin{array}{l} 0{\cdot}12914 \\ 0{\cdot}16295 \end{array}\right\} 0{\cdot}29208 \\
CO_2 = & 7{\cdot}17 & : 44 = & \\
H_2O = & 7{\cdot}71 & : 18 = & 0{\cdot}42833 \\
ZnO = & 0{\cdot}41 & : 81 = & 0{\cdot}00506 \\
F_2O_3 = & 0{\cdot}07 & & \\
\hline
 & 100{\cdot}04 & &
\end{array}
$$

This unusual, and surely novel composition, may give cause for several interpretations. Roughly speaking, it might be an intimate mixture of copper carbonate, copper silicate and copper hydrate; but it may also be interpreted as the basic salt of an ortho-silico-carbonic acid $H_4(Si,C)O_4$, in which Si and C may replace each other within certain limits. A scrutiny of the three analyses shows a practically identical percentage of copper oxide. The percentages of SiO_2 and of the volatiles vary. As to SiO_2, we have 9·91 ("A"); 8·83 ("B"); 7·80 ("C"), a variation of about 1 per cent. In "A" we have 12·52 volatiles; in "B," 14·2; in "C," 14·88. These figures are evidently not due to accident, nor due to mechanical mixture. Unfortunately their significance was recognized only after it was too late for a determination of CO_2 in "A" and "B," for there was nothing, or too little, of the materials left. Notwithstanding this serious experimental deficiency, it seems to me that the logical comparison forces the admission of strength in my hypothesis. Admitted the existence of a complex $H_4(Si, C)O_4 . H_2O$ (and I can see no chemical reasons against it) in which hydrogen is wholly replaced by Cu. and H_2O partly by CuO and in which, moreover, Si and C are atomically interchangeable: but so that the percentage of Cu be constant, then a change in the percentage of Si_2O_2 must influence both the percentages of CO_2 and H_2O. Now, comparing "A" and "C," we find in the former 2·11 SiO_2 *more*, and 2·35 volatiles less than in the latter. 2·11 SiO_2 are equivalent to 1·53 CO_2, leaving 0·82 as that portion of the volatiles attributable to water, thus conforming with the hypothesis.

If the composition of melanochalcite be interpreted according to this plausible hypothesis, the figures of analysis "C" take the following shape.

$$
\begin{array}{lrl}
\text{Molecules} & Si_2O_2 = & 0{\cdot}12914 \\
\text{"} & CO_2 = & 0{\cdot}16295 \\
\hline
 & & 0{\cdot}29209
\end{array}
$$

These 0·29209 molecules require $2 \times 0{\cdot}29209 = 0{\cdot}58418$ molecules of CuO.

There are disposable 0·96583 CuO+0·00506 ZnO, a total of 0·97089 molecules of basic oxides. Deducting from this total the requirements of the silico-carbonate, there will be left 0·97089—0·58418=0·38671 (CuO,ZnO) to constitute with the water, the hydroxide. But we have 0·42833 molecules of water; hence there is a surplus of the latter of 0·42833−0·38671=0·03762. This surplus, which amounts to 0·749 per cent, must be declared present as hygroscopic water. It is not determinable by experiment, since the substance lost at 87 C.—1·63 per cent, and since it is a well-known fact that boiling water converts the hydroxide $Cu(HO)_2$ into the oxide CuO.

Putting together these figures, we get:

Copper silico-carbonate 0·87627 : copper hydroxide 0·77342 = 1·000 : 0·882.

The formula of melanochalcite is:

$$Cu_2(Si,C)O_4 \cdot Cu(HO)_2$$

Paragenesis.—In regard to the forming of this mineral substance, one may conceive of at least two modes:

(1). Cuprite crystallizes first from a solution of copper carbonate, with the coöperation of a deoxidizing agent, and produces centers or nuclei. At a later period an oxygenated aqueous solution of silicon and carbon *meta-acids* invests these nuclei. In presence of an overwhelming basic substratum, the meta condition of the acid changes into the ortho state, and the melanochalcite molecules are formed rapidly, falling out in amorphous aggregates. As the crust increases in thickness the basic substratum's influence decreases and we find mixtures of melanochalcite aggregates with those of chrysocolla and malachite, because the ortho reverts to the meta state. The complex molecule $Cu_2(Si,C)O_4$ is no longer possible; and, shortly after, we have clear alternating bands of chrysocolla and malachite.

(2). One can conceive of an aqueous solution holding from the start all the constituents, excepting only oxygen, and from which the least soluble constituents, i. e., Cu_2O, will fall out first. But considering the great bulk of the latter compared with that of melanochalcite, chrysocolla and malachite, this view would seem less simple than at first. Both are purely hypothetical; no experimental facts are known to me outside of the formation of copper sulphides and arsenides. A large field of investigation is open here. The relative absence of native copper in these Arizona cuprite ores is surprising, because these ores are evidently neither metamorphic nor pseudomorphic; but appear to be automorphic, the same as the native copper ores of Lake Superior.

2. *Keweenawite.*

Occurrence.—In April 1901, driving the fifth level at the Mohawk Mine, Keweenaw Co., Michigan, southwestward from shaft No. 1 to shaft No. 2, a narrow cross vein was cut through, carrying domeykite and a reddish-metallic mineral having the color and general appearance of massive niccolite. Superintendent Fred A. Smith sent me some of the material. Being very busy at the time, I did not investigate this matter until June, after my vacation had begun. The examination revealed then my wrong, first impression, inasmuch as the substance showed copper, nickel, arsenic in the ratio of 2 : 1. Early in July I visited the mine and informed Superintendent Smith that I proposed the name *Keweenawite* for this undoubtedly new mineral species. I went under ground for the purpose of gaining some knowledge of the paragenesis of the arsenides for which this mine has now become famous. The large domeykite-mohawkite vein crosses the amygdaloid copper-bearing bed near the No. 1 shaft at an angle of nearly 45°. The arsenides in large shining masses sit mostly against the reddish amygdaloid, without the intervention of any selvage. There is little parallelism among the several minerals (the least soluble species forming the bordering fringe), which suggests the notion of the fissure having been filled by crystallization from a standing mother liquor. In the absence of parallelism, the mother liquor must have been in motion. The stoping operations on this vein between the second and third levels tend to show the vein as a system of flat lenses. One of them has been stoped out with a rich yield. I found the new vein to be about 1,300 feet from the large one just described, near shaft No. 2. The vein comes into the level very flat, almost parallel with the strike of the bed. It is thin, with a maximum width of 6 inches. The general character is very like that of the large vein; to wit, absence of parallelism. Sometimes calcite sits against the amygdaloid, sometimes quartz, or again either domeykite or keweenawite. The conditions under which the filling out of the vein took place must have been alike in both veins. I intended to analyze a large sample of the amygdaloid adjacent to the vein in order to learn whether the arsenic pervades the rock in minute quantities, to find proof or disproof of a lateral leaching. Thus far I have not done this, though the intention still exists. This is one of the reasons why I kept back the publication of the present notice.

Physical Properties.—I have observed the mineral only as a massive, very fine granular aggregate which is very brittle and shows flat conchoidal fracture. Hardness about 4, similar to that of domeykite. The color on the fresh fracture is pale pinkish brown. On exposure tarnishes to a deeper brown red; but is far more constant towards the atmospheroids than domeykite or mohawkite. I have now some specimens before me which have been exposed to the laboratory gases for over a year and still show the characteristic color, but slightly deepened. Specific gravity at 20° C. = 7·681 (with 3·140 grams of the mineral).

Chemical Characters.—B. B. melts easily to a globule. Gives vapors of arsenic. On continued blowing in oxidizing flame, a metallic globule is obtained. But if a borax bead be placed along the globule from the first, while the O. F. is acting, then a blue glass is obtained; later a brown glass, and ultimately a green glass, showing successively cobalt, nickel, copper. The qualitative behavior is thus identical with mohawkite. Dissolves in concentrated HNO_3 and even in HNO_3 (specific gravity 1·2).

A first preliminary quantitative determination gave Cu = 38·5; (Ni + Co) = 17·98; quartz = 4·52; no iron—the difference must be arsenic. This was very different from mohawkite.

A second analysis of the same sample, carefully made with 0, 500 grams, gave

0·0249 insoluble
0·3760 $Mg_2As_2O_7$
0·2449 Cu_2S
0·0945 Ni + Co (by hydrogen)
0·0047 Co (by hydrogen).

From this follow the percentages.

Quartz	= 4·98			
As	= 36·96	: 75	= 0·493	
Cu	= 39·12	: 63	= 0·621	0·944
Ni	= 17·96	: 58·6	= 0·325	
Co	= 0·94			
Fe	= trace			
	99·96			

Thus the ratio obtains As : (Cu,Ni,Co) = 1,000 : 1,915 and again Cu : (Ni + Co) = 2 : 1 nearly.

It was assumed by me that this ratio between the metals would probably not be constant; but instead to a certain limit a replacement of each by the others, the same as was assumed for the mohawkite and has been fully proven by numerous analyses, I have made since.

Keweenawite = $(Cu,Ni,Co)_2 As$.

This result was communicated to Superintendent Smith at my visit to the mine on July 6, 1901. The material had come from the sixth level. I collected material at the vein crossing on the fifth level. In appearance it was identical with the one just described. The analysis made with 0·5 gram samples gave the following data :

0·3379 Cu_2S
0·0487 Ni
0·0047 Co
0·3560 $Mg_2As_2O_7$
0·0039 quartz.

The percentages are :

Cu	= 53·96	: 63	= 0·856
Ni	= 9·74	: 58·6	= 0·182
Co	= 0·94		
As	= 34·18	: 75	= 0·456
Quartz	0·78		
	99·60		

The ratio (Cu,Ni,Co) : As = 2·27 : 1, is not so close to 2 : 1 as that of the first material, but still sufficiently so. The material, though freer from quartz, was not so faultless throughout as the first. There appeared certain pseudocleavages along which a thin olive-green film could be seen. Just to what extent this condition has to do with preponderance of the metals over the arsenic, I am not prepared to say. But on the other hand, this analysis shows unmistakably the replacement of copper by nickel, and vice versa.

A third analysis was made with another sample, the arsenic not determined.

Quartz	= 0 60			
Cu	= 40·72	: 63	= 0·646	0·992
Ni	= 19·42	: 58·6	= 0·346	
Co	= 0·82			
Fe	= trace			
(diff) As	= 38·42	: 75	=	0·515
	100·00			

(Cu, Ni, Co) : As = 1·128 : 1

In my paper on mohawkite (this Journal, December, 1900) I showed how an arsenide Cu_2As forms very easily when the vapors of arsenic act upon copper at red heat. This artificial Cu_2As shows the color and crystalline structure of chalcocite. The difference in color in keweenawite must, therefore, be owing to the nickel.

I give the specific gravity (l. c.) as 7·71, the calculated specific gravity as 7·75, whilst the keweenawite gives the gravity 7·681, which is very close indeed. Nickel and cobalt having nearly the same specific gravities and not much different from copper, this slight difference is readily accounted for.

3. *Mohawkite and Domeykite.*

During the past year I have made several more analyses of these two minerals from the Mohawk mine. The material was in part collected by me on the spot or sent to me by Mr. Fred Smith, to whom I wish to express my indebtedness.

The colors of these minerals seem alike to those of the fabled chameleon, and the identification by the eye is made very difficult, in fact impossible.

a. The mineral appears in form of large masses in calcite with a color equaling that of chalcopyrite; altogether unlike any previously seen domeykite or mohawkite. Mr. Smith states that it had this yellow color when it came up the shaft. It is exceedingly brittle, crumbling between fingers into blue and purple fragments. B. B. shows trace of cobalt and trace of antimony.

$$\begin{array}{l}\mathrm{Cu} = 70{\cdot}56 \\ \mathrm{As} = 29{\cdot}50\end{array}$$

It is therefore domeykite.

b. Large iron gray mass, looks like arsenopyrite. B. B. gives strong cobalt reaction.

$$\begin{array}{lr}\mathrm{Cu} & = 67{\cdot}86 \\ \mathrm{Ni} + \mathrm{Co} & = 3{\cdot}32 \\ \mathrm{As} & = 28{\cdot}10 \\ \hline & 99{\cdot}28\end{array}$$

The mineral proves to be *mohawkite;* but the sum of cobalt and nickel is only one-third of that in my original mohawkite.

c. Mr. Knight, one of my students, picked up a specimen at the Mohawk mine, which seemed to be peculiar. It is tough, but not so much as what I have called mohawk-whitneyite, gray color and fine granular structure somewhat like algodonite in appearance.

B. B. reaction for antimony, no cobalt, no nickel.

Spec. gr. 8·378 — 8·364 (with 1·747 grams)

$$\begin{array}{lrcrcl}\mathrm{Cu} & = 80{\cdot}72 & : & 63 & = & 1{\cdot}281 \\ \mathrm{As} & = 19{\cdot}12 & : & 75 & = & 0{\cdot}255 \\ \mathrm{Sb} & = 0{\cdot}84 & : & 120 & = & 0{\cdot}007 \\ \hline & 100{\cdot}68 & & & & \end{array}$$

$$\mathrm{Cu} : (\mathrm{As},\mathrm{Sb}_6) = 4{\cdot}9 : 1 = 5 : 1$$

On the face of this result the establishment of a new species would seem indicated. But as I have expressed myself (l. c.), the higher ratios of these copper arsenides are either downright mixtures (grain very fine) or they pertain of the nature of alloys and hence all ratios are possible. In order to throw a little more light on this subject, a long sliver was knocked off the type specimen. On this sliver the mixture of two substances was discernible. The sliver was broken into three fragments and in each the copper was determined.

α (0·5063 gram) gives Cu_2S = 0·4836 per cent Cu = 76·2
β (0·500 gram) " " = 0·4743 " Cu = 75·76
γ (0·506 gram) " " = 0·5097 " Cu = 80·10

These differences would seem to bear out my statement. A straight ratio marks an accident rather than a necessity. In speaking of mixtures like these, it may perhaps be well to use the term *mohawk-algodonite*, as distinguished from true algodonite.

d. Mr. Rogers, another of my students, collected a specimen which did not quite correspond to anything I had seen before. It was much tougher than the preceding specimen. A fragment weighing 0·391 gram was dissolved and the copper determined. Arsenic by difference. Nothing insoluble.

Cu_2S = 0·4208, Cu = 0·3361 = 85·9
As = = 14·1
———
100·0

Ratio 7·25 : 1

It must be classified as *mohawk-whitneyite.*

e. Genuine Algodonite from the Champion Mine, on the South Copper Range.

I am indebted to Dr. L. L. Hubbard, the Superintendent, for the specimen. It presents a piece weighing about 400 grams, through which a drill-hole passes. The specimen was encountered on a cross vein, very narrow, similar to the occurrence at the Mohawk mine. The metallic mineral is intimately mixed with calcite. The fresh fracture is steel grey. Several fragments were digested with dilute HCl. The residue carefully washed and dried weighed 0·1968 grams. This quantity was dissolved in HNO_3 and boiled nearly to dryness in order to bring all the arsenic to the form H_3AsO_4. Only a trace of white insoluble material (quartz) was observed.

0·0683 $Mg_2As_2O_7$ = 0·0328 As
0·2063 CuO = 0·1645 Cu
Hence Cu = 83·53
As = 16·55 **Cu : As = 5·96 : 1**
———
100·18

f. Pulveriform chalcocite from the Champion Mine.

This very interesting material was also encountered in a small cross vein and recognized by Dr. L. L. Hubbard as something peculiar. Neither of us thought of chalcocite. It soils the paper or fingers like soft pyrolusite or graphite. An aggregate of small crystals, the largest less than $0·5^{mm}$ to microscopic individuals.

The dust appears under the microscope as made up of single hexagonal plates, or groups of plates, easily disengaged and reduced to individuals, perfectly opaque. I have since observed this same substance both at the Champion and Mass mine, dusting over groups of calcite crystals, either loosely or firmly imbedded in the calcite, causing the latter to look gray or black. It becomes bluish by tarnish. B. B. reacts for copper and sulphur only. The record of the quantitative analysis is lost; but I remember distinctly that the percentage of copper was close to 79.

g. Nodular nuggets found in the coarse material from the mortar at the stamp mill of the Baltic mine were singled out by Mr. William Vivian as whitneyite. If seen by themselves they look much like rounded native copper; but seen alongside of the latter a difference becomes noticeable even to the untrained eye. Compared with one another, on filed or ground surface, slighter differences appear. Held in a vise, a strong blow with a cold-chisel will break the whole in two. Native copper will not do this. The fracture is hackly; there are small geodes of calcite. Calcite is visible between the imperfect crystals of gray color. But the lens also reveals minute black globular bodies. These latter I succeeded in identifying as chalcocite. The material for analysis was extracted with diluted HCl. After extraction material weighed 0·4003 gram.

It gave: Insolubles $= 0·0081$; $Cu_2S = 0·4575$; $Mg_2As_2O_7 = 0·0555$

Hence: Cu = 91·33 : 63 = 1·450
As = 6·60 : 75 = 0·0888
Quartz = 2·20

100·13 Cu : As = 16·22 : 1

h. From Captain James Hoatson, of Calumet, I received a specimen showing quartz and what looks like native copper, at first sight. The supposed native copper is similar in color to the nodules just described; also similar in hardness and relative toughness. A filed surface shows a very uniform, dense texture, with a decided yellowish, brassy, color; but etched with HNO_3, the heterogeneous nature becomes visible even to the naked eye.

Two fragments gave:

Cu = 92·78	Cu = 93·96	1·4755	Cu : As = 18·8 : 1
As = 5·85	As = 5·74	0·0765	Cu : As = 19·3 : 1
98·63	99·70		

Two other fragments were detached close to the one whose composition has just been given.

They gave:

Cu =	96·2 and	94·5	
As =	3·8	5·5	(by difference)
	100·0	100·0	

Here the ratios are Cu : As = 30·1 : 1 and 25·5 : 1. The figures show plainly that definite proportions cannot be looked for; but they indicate, as I look at it, that we must assume here conditions similar to those of pig iron, or of alloys. Further studies may give better light, especially in the direction of etching. In speaking of such alloys as these (*g*, *h*), I venture to propose the word "*Semi-Whitneyite*," to be used like Mohawk-Whitneyite, or Mohawk-Algodonite, meaning neither a species nor a variety; in the sense of a rock rather than of a mineral.

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