

PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

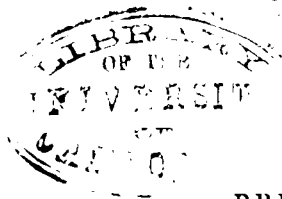
HELD AT PHILADELPHIA

FOR

PROMOTING USEFUL KNOWLEDGE.

Vol. XXV.

JANUARY TO DECEMBER, 1888.



PHILADELPHIA :
PRINTED FOR THE SOCIETY
BY MAC CALLA & COMPANY.
1888.

- 112.—It is bad to drink water before seating oneself for a meal.
- 113.—A coin with a hole in it should be kept as a pocket piece for good luck.
- 114.—It is unlucky to eat in the street.
- 115.—It is unlucky to burn bread or other food.
- 116.—Children are told that if a dog should get one of their extracted teeth, they will get a dog's tooth in its place.
- 117.—Children are told that if they refrain from putting their tongue in the cavity from which a tooth has been extracted, that they will have in its place a *golden tooth*.
- 118.—To stop a dog from howling at night one's shoes must be turned upside down when the sound is heard.
- 119.—To find any lost article a key is placed in a Bible or large book, then fastened and held in such a manner that it can move. At the mention of the place where the lost article is, or the person who took it, the book will make a movement.
- 120.—It is very unlucky to stumble.
- 121.—It is unlucky to kill a lady bug.
- 122.—To kill a lady bug will produce a thunder storm.

NOTE.—According to the eminent scholar, D. Alejandro Gulchot y Sierra, the following of the foregoing superstitions are likewise current in Andalusia :

Birth, Death and Marriage—Nos. 16, 17, 18, 19, 20 ; *Weather, Celestial*—Nos. 2, 6, 7, 8 ; *Weather, Terrestrial*—Nos. 2, 15 ; *Medicine*—Nos. 6, 16.

General Superstitions—Nos. 31, 32, 33, 35, 36, 37, 88, 39, 40, 41, 42, 43, 45, 51, 52, 55, 56, 62, 63, 64, 67, 68, 81, 88, 89, 109, 111, 112, 114.

The Classification and Nomenclature of Metalline Minerals.

By T. Sterry Hunt.

(Read before the American Philosophical Society, May 4, 1883.)

1. The writer in April, 1885, presented to the National Academy of Sciences the project of A Natural System in Mineralogy, which was farther elaborated in an essay before the Royal Society of Canada in May of the same year, published in Volume III of the Transactions of that Society, and with revisions and additions, in his Mineral Physiology and Physiog-

raphy in 1886 (pp. 279-401).* In this essay it was maintained that such a system cannot be established on the sensible characters of the species alone, as taught by the school of Mohs, nor yet on chemical composition and relations, to the neglect of such characters, in accordance with the views of the Berzelian school, or of those who propose a chemico-crystallographic scheme like that of Groth. It was the aim of the writer to show that the hardness, the specific gravity, and moreover the greater or less susceptibility to chemical change in species, are intimately related to chemical constitution; and that a natural system of classification, which, in the words of John Ray, "neither brings together dissimilar things, nor separates those which are nearly allied," must take into account all these various characters and relations, alike dynamical and physical. The error of attaching an undue importance to a single subordinate character is illustrated in the case of crystalline form, which may vary, while specific gravity, hardness, color, lustre and chemical composition all alike remain unchanged, as seen, for example, in the native sulphids of zinc and of silver.

In pursuance of these ideas, the whole inorganic kingdom was declared to belong to Mineralogy, although as a branch of Natural History it is generally confined to native species. The real position of mineralogy, as distinguished under its various heads of Systematic, Descriptive and Physiological Mineralogy, is set forth in the following tabular view of the natural sciences, copied, with slight revision, from the volume just cited.

NATURAL SCIENCES.		INORGANIC NATURE.	ORGANIC NATURE.
		DESCRIPTIVE. — General Physiography or Natural History.	MINERAL PHYSIOGRAPHY. — Astronomy, descriptive. Mineralogy, descriptive and systematic. Geognosy. Geography.
RATIONAL. — General Physiology or Natural Philosophy.	MINERAL PHYSIOLOGY. — <i>Dynamics. Chemistry.</i> Astronomy, theoretical. Mineralogy, physiological. Geogenesis.	BIOPHYSIOLOGY. — <i>Biötics.</i> Organogenesis. Morphology. Botany and Zoölogy, physiological.	

2. The classification then proposed by the writer, divides the mineral

*See also, Supplement to A Natural System of Mineralogy, Trans. Roy. Soc. Can. for 1886, Vol. iv, Part 3.

kingdom into four classes, namely: I, *Metallic*; II, *Oxydized*; III, *Haloid*, and IV, *Pyricaustate* (combustible or fire-making) species. These again are divided into orders, and in some cases into suborders, as was set forth on page 382 of the already cited volume. In the large and important order of the SILICATES, the only one then considered in detail, there was recognized in each one of its three suborders of Protosilicates, Protopersilicates and Persilicates—five tribes, designated Hydrospathoid, Spathoid, Adamantoid, Phylloid and Colloid (or Porodic); called, in some cases, by other more distinctive synonyms, as Pectolitoïd, Zeolitoïd, Ophitoïd and Argilloïd; in farther extension of which, we may say Amphiboloid, Feldspathoid, Granatoid, Topazoid, Talcoïd, Micoid, etc., for the other tribes. The characteristic species of these tribes were then critically examined as regards chemical composition and the relations of this to specific gravity and to hardness. These relations were shown in separate tables for the various tribes, and farther in three synoptical tables of the suborder (*loc. cit.*, pp. 399-401). The order of the OXYDATES (included, like the last, in the class of the OXYDACEÆ) was, at the same time, more briefly considered, and shown to include representatives of five similar tribes (p. 376). In various orders of the same class, such as CARBONATES and BORATES, as likewise in the suborders of the HALOIDACEÆ, such as CHLORIDS, the soluble and sapid species were recognized as forming tribes—Carbosalinoïd, Borosalinoïd and Chlorosalinoïd—contrary to the teaching of Mohs and his followers, who made these characters the basis of a class-distinction. It should be added that the species of all these various tribes have farther to be arranged in genera, and, to complete the system, require a binomial Latin nomenclature.

3. In the study of the various species of the order of Silicates, notice was, in every case, taken not only of the specific gravity of the species, but of the relations between this and its equivalent or so-called molecular weight, as shown in what is generally known as its atomic volume, calculated by the formula, $p \div d = v$. For the purpose of thus comparing related species it was necessary to fix a simple unit for p . As we have since said, in the study of the species of Classes II and III: "We assume as the unit for p a weight including that of H = 1.0, of Cl. = 35.5, or of O $\div 2 = 8.0$. By thus adopting a combining weight of 8.0 for oxygen, as a basis, we get a unit which gives a common term of comparison for oxyds, sulphids, chlorids, fluorids, and for intermediate compounds like the oxysulphids and oxyfluorids common in native species. It is, of course, a hypothetical unit, which, for elemental species, and for fluorids, chlorids, etc., corresponds with the normal vaporous species; but for oxydized species is some fraction thereof, as in the cases of water-vapor, H₂O, of spinels, and other oxyds.

"We may readily extend this system of hypothetical units from silicates to carbonates, sulphates, phosphates, and more complex species, by dividing in all cases the empirical equivalent weight by twice the number

of oxygen portions ($O = 16.0$), plus the number of chlorine or fluorine portions. We have for example :—

	<i>p.</i>
Forsterite..... $\text{SiMg}_2\text{O}_4 = 140 + 8$	17.50
Calcite..... $\text{CCaO}_3 = 100 + 6$	16.66
Karstenite..... $\text{SCaO}_4 = 136 + 8$	17.00
Gypsum..... $\text{SCaO}_4.2(\text{H}_2\text{O}) = 172 + 12$	14.33
Apatite..... $3(\text{P}_2\text{Ca}_2\text{O}_8). \text{CaF}_2 = 908 + 50$	18.16

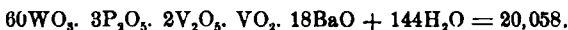
“In the writer’s late essay on A Natural System in Mineralogy, the values of *p* have been thus determined. These silicates are there represented by a new notation, which employs symbols in small letters to represent quantivalent ratios; the combining weights of the elements being divided by their valency, and in all cases followed by their coefficients. The formula of forsterite thus becomes $(\text{mg}_1\text{si}_1)\text{o}_2$, that of orthoclase, $(\text{k}_1\text{al}_1\text{si}_1)\text{o}_{16}$, and that of topaz, $(\text{al}_1\text{si}_1)\text{o}_4\text{f}_1$.

“While a similar unit is equally applicable to all haloid species, it has been found more convenient for the metalline species which constitute Class I, including unoxidized metals and their compounds with one another and with arsenic, antimony, sulphur, selenium and tellurium, to divide the formula by the sum of the valencies therein represented; so that for all such species the unit *p* gives not the mean integral weight of an oxygen compound in which $O = 8$, but that of the element, corresponding to $S = 16$, to $\text{Fe} = 28$, to $\text{Ag} = 108$, to $\text{As} = 25$, $\text{Sb} = 40$, and $\text{Bi} = 69.3$,”* represented respectively by s_1 , fe_1 , ag_1 , as_1 , sb_1 , bi_1 .

4. The law of condensation and of expansion by volumes, familiarly known in the chemistry of gases and vapors at ordinary pressures, is, as the writer has endeavored to show, still further exemplified in the case of the very dense vapors into which, under much greater pressures, liquids like water, alcohol, hydrocarbons, and theoretically, all chemically stable liquids, pass when heated sufficiently; that is to say above their so-called critical points, when they necessarily assume the vaporous condition. The conversion of all gases and vapors, by reduction of temperature and augmentation of pressure, into liquid and solid forms, helps us to understand that the same laws of combination by weight, and of condensation or integration of volume, apply alike to gases and vapors on the one hand, and to liquids and solids on the other. The relation of condensation (represented by specific gravity) to equivalent weight, which thus becomes a fact of fundamental importance, is shown by comparing the quotient got by dividing the received equivalent (so-called atomic or molecular) weight by the specific gravity of the body, as determined for all liquid and solid species, taking water as unity, as in the formula $p + d = v$. The equivalent weight *p* is, as we have seen, that deduced from the empirical chemical formula calculated from hydrogen as unity.

* A New Basis for Chemistry, 2d Edition, § 139; also the author on Chemical Integration, *American Journal of Science*, August, 1887.

Thus hydrogen being $1 = H$, the equivalent weight of carbon dioxide, whether as gas, liquid or solid is assumed as $44 = CO_2$; that of water in any of its states is taken as $17.96 = H_2O$, and that of the various forms of silica as $60 = SiO_2$; while that of carbonate of lime, whether as calcite or aragonite, is $100 = CaCO_3$. These weights in the case of gaseous bodies are really the weights of equal volumes, compared with that of hydrogen at the same temperature and pressure, and are truly equivalent weights. The law of condensation, however, shows us that in the case of liquid and solid species we have to deal with much more complex formulas than these. In fact, the minimum equivalent weights deduced from analyses of the chlorides of the ammonio-cobalt bases give numbers of 500 and upwards, and in the case of a certain metaphosphate, equal 2,540. The complex potassio-cobaltic nitrite is represented by a formula giving an equivalent weight of not less than 958. These weights are surpassed by those deduced for the complex silicotungstates, and phosphotungstates, our knowledge of which has been much extended by the late researches of Wolcott Gibbs on what he has called "the complex inorganic acids." Therein he has made known the existence of progressive or homologous series, the successive terms of which differ by $2WO_3$, and rise from $4WO_3$ to $24WO_3$, and even $60WO_3$; having formulas from which the minimum molecular weights deduced are represented by many thousands, $H = 1$. Thus the golden insoluble crystalline compound of tungsten, oxygen and sodium described by Wöbler is probably, according to Gibbs, $16WO_3 \cdot 4WO_3 \cdot 7Na_2O = 5,002$, while to another crystalline species, soluble in water, and hydrous, he ascribes the formula,



This, according to him, has "the highest molecular weight yet observed." The studies of Gibbs and of many others, whose work in this field has been briefly summarized by the writer (*Mineral Physiology*, etc., pp. 386-389), unite in showing that a great complexity of composition may exist in definite crystalline compounds, and moreover that very small portions of different substances may not only occur as necessary elements in such a compound, but may even change essentially its chemical relations. Thus in a complex tungstate containing $12WO_3 = 2784$, the addition of $SiO_2 = 60$, suffices to determine the production of a new type, with changed basicity. In like manner the addition to a compound containing $24WO_3 = 5568$, of $P_2O_5 = 142$, gives a new and distinct acid type. Moreover, oxygen in these bodies may be in part replaced by fluorine; while platinum, selenium, tellurium and many other elements may enter in small but definite amounts into the polytungstates and polymolybdates, as well as organic radicles, such as methyl, ethyl and phenyl. These remarkable results are regarded by Gibbs as forming "a new department of inorganic chemistry." In commenting upon them, however, it has been elsewhere said:

"It will be remembered that I had already, in 1853, proclaimed that

the whole chemistry of solids and liquids is only intelligible when regarded as a history of just such complex inorganic acids and salts; that the distinction between organic and inorganic chemistry is no longer tenable; that the same principles of homology and polymerism are applicable alike to the bodies of the carbon series and the silicon series; that the native crystalline carbonates, or carbon-spars, are polycarbonates, with equivalent weights of not less than from 1500 to 2500; that the pyroxenes, feldspars, and tourmalines are polysilicates of equally complex constitution, and are represented by formulas which show the existence among them both of polymers, probably homologous, and of anisomeric homologues. These conceptions, all of which were explicitly set forth and defended in 1852 and 1853, underlie the writer's philosophy of the mineral kingdom, as then enunciated, and as persistently maintained to the present date."*

5. It was not, however, until a much later date that a farther attempt was made to fix the *integral weight*, as I have designated the so called molecular weight of solid species. By extending to such species the law of equivalent volumes, the conclusion was reached that their integral weights were even far greater than had been suspected by the writer in 1853. In fact, that of water itself, the unit of specific gravity for liquids and solids, being in round numbers 21,400;† the weights for these various species must be as much greater as their specific gravities are higher than this unit. We thus find that the solid forms of carbon dinoxyd and silicon dinoxyd, of carbonate of lime, and even of the ammonia-cobalt salts, and the highest members of the polytungstate series, represent in all cases polymeric or condensed derivatives of the normal species; which is for the most part unknown, or appears, as in the case of CO_2 and H_2O , in a gaseous form. A species like calcite of specific gravity 2.729, is represented by 584CaO_3 or by $\text{C}_{381}\text{Ca}_{384}\text{O}_{1752} = 58,400$. In like manner other mineral species must be represented by formulas more complex, and weights far higher, than those deduced by Gibbs for his polytungstates. In the case of such compounds, partial substitutions and small additions, affecting but slightly the centesimal composition of a species, may nevertheless be essential to its chemical constitution, as shown by Gibbs in the cases of silicic and phosphoric oxyds added to the polytungstates. In the formula above assigned to calcite, with Ca_{384} , the substitution of Mg_{10} , would introduce into the species only 0.72 of magnesia. Such substitutions and

* A New Basis for Chemistry, 1887, § 27.

† In liquid water 1192 volumes of water-vapor at standard temperature and pressure are condensed into a single volume, which if $\text{H}_2\text{O} = 17.96$ gives an integral weight of 21,408; but in view of the uncertainty still prevailing as to the precise weight of oxygen, hydrogen being unity, the number 21,400 is adopted as a close approximation. In former publications by the writer, by an error in calculation, instead of $1192\text{H}_2\text{O}$ the formula of water has been given as $1628\text{H}_2\text{O}$, which with $\text{H}_2\text{O} = 17.9633$, gave an integral weight of 29,241. This mistake was corrected in a note on The Integral Weight of Water, in the *L. E. and D. Philos. Magazine*, for April, and in the *American Journal of Science*, for May, 1889. See also the author's New Basis for Chemistry, 2d Edition, *passim*.

small additions would, however, if found in ordinary analyses of mineral species, be disregarded, as impurities not essential to the composition. In like manner the small amounts of fluorine, of chlorine, of hydrogen, of boron, and of phosphorus, so often met with in native silicates, are not to be looked on as accidental ingredients, but as essential parts of highly complex integers. Farther and more critical chemical analyses are necessary before we can fully know the constitution of dense insoluble species, and the great difficulty is to decide how far these small portions of elements are due to impurities, and how far they are elements necessary to the constitution of the species; questions which in many cases can only be solved by much care and study.

6. The non-oxidized metalline minerals, embracing the metals, their alloys, and all their compounds with sulphur, selenium, tellurium, phosphorus, arsenic, antimony and bismuth, are, in the natural-historical classification of Mohs and his followers, comprised in four orders—Pyrites, Metals, Glances and Blendes (Pyrites, Metalli, Lamprites and Minia of Breithaupt). All of these we have included in Class I, METALLACEÆ, embracing but a single order METALLATA, which is, however, divided into two suborders. The reasons for including the metals and their various alloys in the same order with sulphids, selenids, tellurids, phosphids, arsenids, antimonids, bismuthids, sulpharsenids; sulphantimonids, etc., are two-fold; first, the resemblances between the typical and malleable metals, such as gold, silver, lead, copper, nickel, and iron, and the elementary metalline species, tellurium, arsenic, antimony, and bismuth, are such that the compounds of these with the metals above named cannot well be separated from alloys. Another reason is to be found in the complex nature of many artificial products known to us as metals. Thus the cast irons from the blast-furnace are compounds, apparently homogeneous, of iron with small quantities of sulphur or of phosphorus, with silicon, and with carbon; while copper may in like manner contain small quantities of phosphorus, of arsenic, or of silicon. These constitute sulphids, phosphids, arsenids, silicids and carbids of iron and of copper, in which the amounts of the added elements, though proportionally small, nevertheless, modify profoundly the character of the compounds, affording additional illustrations of the principle insisted upon above in speaking of oxidized species.

7. The division of the Metallata into two suborders, which we have designated Metallometallina and Spatometallina, is based upon the radical differences which distinguish the great groups of the Glances and the Blendes. The first suborder, like the Glances, includes alike simple sulphids like galena, argentite, chalcocite, metacinnabar, stibnite and molybdenite; selenids like eucairite and clauthalite; tellurids like altaite, sylvanite and tetradymite; sulpharsenids like enargite; sulphantimonids like bournonite and stephanites; ulphobismuthids like emplectite and kobellite. To the Metallometallinae also belongs the order Pyrites of Mohs. This not only includes the harder simple sulphids as marcasite, pyrite, siegen-

ite and laurite, and as pyrrhotite, chalcopyrite and millerite ; but arsenids such as smaltite, leucopyrite and niccolite ; antimonids like breithauptite, horsfordite and dyscrasite ; sulpharsenids like arsenopyrite and cobaltite ; sulphantimonids like ullmannite ; and sulphobismuthids like grunauite. In this same suborder, for reasons already given, belong the metals and alloys, including metallic arsenic, antimony and bismuth, and also the metallic forms of selenium and of phosphorus.

In the second suborder the metals are not represented by any known species, but by the non-metallic forms of selenium and phosphorus, and by the various modifications of sulphur. This suborder includes, moreover, simple sulphids like sphalerite, wurtzite, greenockite, hauerite, oldhamite, cinnabar and realgar ; sulpharsenids like proustite and tennantite ; and sulphantimonids like pyrargyrite and miargyrite. The opacity and lustre of the compound species of the first suborder, and their occasionally sectile character, connect them closely with the typical metals. On the other hand, the transparency, the absence of metallic lustre and aspect from the species of the second suborder recall the physical characters of oxyds like zincite, cuprite and senarmontite, with which they are connected through the oxysulphids, voltzite and kermesite. It is to recall these resemblances to the sparry Oxydates that we have called this suborder, Spatometallinea. It is worthy of note that not only the elements selenium and phosphorus, but the sulphids of mercury and of antimony are found in two distinct specific forms, and belong to both of these suborders ; and there seems some reason to believe that under the head of fahlerz or gray copper may be included, besides the species belonging to the Spatometallinea, others which pertain to the Metallometallinea.

8. In proceeding to divide into tribes and genera the various groups of species indicated in the preceding review of the order of Metallata, we are guided alike by the composition, as shown by chemical analysis, and by the physical characters of hardness and condensation. The latter, as indicated by the value of v , calculated for the elemental unit as already defined (§ 3), is the reciprocal of the coefficient of condensation. This value will be seen to diminish with the increase of hardness of the species, as represented by degrees given on the scale of Mohs, in which the hardness = $H = 1.0 \dots 10.0$.

In fixing the value of p for those metals which like iron and chromium, like copper, mercury, gold, tin, palladium and platinum, yield two distinct chlorids, we have in all cases taken the amount of metal which, in the ferrous, chromous, cuprous, aurous, stannous, palladous and platinous compounds, is combined with one portion (35.5 parts) of chlorine. A similar rule, as already shown (§ 3), is applied in the case of arsenic, antimony and bismuth. This unit-weight of the metal = p , when divided by d —the specific gravity, water = 1.000—gives the value of v .

(1.) The metals and their alloys, which we include in the tribe of the Metalloidea, present, unlike the other tribes of the order, wide differences

in hardness, condensation, fusibility and chemical characters, which can now only be briefly noticed. Of the hard and less fusible metals, chromium, manganese, iron, nickel and cobalt with $p = 26-29.5$, give values for $v = 3.4 - 3.6$; while the denser group of palladium, rhodium and ruthenium, with $p = 52 - 53$, and also the still heavier group of platinum, iridium and osmium, in which $p = 97 - 99$, agree in having $v = 4.5 - 4.6$. The softer and more fusible metals, gold and silver, give $v = 10 - 10.5$; the value of v for solid mercury being 13.9, for lead 9.2, for tin 8.0, and for cadmium, copper and magnesium 6.5 - 6.9. With these it is instructive to compare the values of v for the alkali metals, caesium = 70, rubidium = 56, potassium = 44, sodium = 24, and lithium = 12; as also barium, strontium and calcium, in which v is from 12.5 to 17.5.

(2.) The tribe of the Galenoideæ is conveniently divided into the three subtribes of sulphids, selenids and tellurids, which we designate Thiogalenoideæ, Selenogalenoideæ and Tellurogalenoideæ. Of these, the first includes the typical genus Thionites, embracing the native sulphids of lead, silver and copper, together with metacinnabar, stibnite and bismutite; having $H = 2 - 3$; $v = 7 - 8$. The subtribe of the Selenogalenoideæ includes a genus which may be called Eucairites, embracing besides eucairite (cuproso-argentic selenid) various other selenids of lead, silver, copper, mercury and bismuth; $H = 2 - 3$; $v = 8 - 9.5$. The subtribe of Tellurogalenoideæ includes various tellurids of silver, gold, lead, mercury, nickel and bismuth, with $H = 2.5 - 3.5$; $v = 8 - 10.5$; which we include in the genus Tellurites. The soft flexible foliated sulphids like sternbergite, argyropyrite, friesite, covellite, and perhaps molybdenite, may constitute a second genus of the first subtribe, with the name of Thiophyllites; while tetradymite and nagyagite perhaps may form a similar division of the Tellurogalenoideæ, as Tellurophyllites.

(3.) In the third tribe we include many sulphids which are near in hardness, in condensation, and in other characters, to the last, and are chiefly sulphids of lead, copper and silver united with sulphid of antimony, of bismuth, or more rarely of arsenic. The antimonial species of this tribe are represented by the well-known species, bournonite; from which the name of the tribe, Bournonoideæ, and the genus Bournonites; having $H = 2 - 3.5$; $v = 7 - 8.5$. The large group of bismuthic species, having similar values for H and v , and many other points of resemblance, of which emplectite is a representative, constitute the genus Emplectites. These two genera present instructive examples of progressive series, especially in the double sulphids of antimony and lead, $Sb_2S_3 \cdot nPbS$ in which n has values of 1, 2, 3, 4, 5, 6, and, in a related species, even equals 12. The species enargite is an arsenical bournonite, and to this tribe may perhaps belong some of the forms of fahlerz or gray copper ore.

(4.) The next three tribes are distinguished from the two preceding—which correspond to the Glances of the natural-history system—by their much greater hardness and condensation, and were included in the order

Pyrites of the same system, but are here divided on chemical grounds. The tribe of the Pyritoideæ may be divided into two genera, the harder designated as Pyrites with $H = 5.5 - 6$; $v = 3.8 - 4.5$, includes cubic and prismatic iron pyrites, with linnæite, siegenite, carrolite and laurite; while the genus Pyritinus, $H = 3.5 - 4.0$; $v = 4.5 - 5.5$, embraces troilite, pyrrhotite, allabandite, millerite, pentlandite, chalcocopyrite, cubanite, and probably stannopyrite.

(5.) The tribe of Smaltoideæ includes the various arsenids of cobalt, nickel, and iron, of which leucopyrite and smaltite are representatives, and which we have included in the genus Smaltites, with $H = 5 - 6$; $v = 3.6 - 4.5$. The arsenids of copper, with less hardness and a higher value for v , will form a distinct genus, Algodonites. Closely related to Smaltites is the antimonial species, breithauptite; while the antimonid of copper, horsfordite, and apparently dyscrasite, are near to Algodonites.

(6.) The tribe of Arsenopyritoideæ, embracing the genus Arsenopyrites, includes the compounds of sulphid of arsenic with sulphids of iron, cobalt and nickel, of which arsenopyrite or mispickel is a type, $H = 5 - 6$; $v = 2.9 - 3.5$. Near to these are some little known double sulphids holding antimony and bismuth, as ullmannite, corynite, alloclasite and grunauite.

(7.) Passing now to the suborder Spatometallinea, we have in the tribe Spatometalloideæ those forms of phosphorus and of selenium which are wanting in the metallic characters, including the colorless and the ordinary red phosphorus, apparently two forms of selenium, and the various known species of sulphur.

(8.) The tribe Sphaleroideæ includes the genus Sphalerites, embracing sphalerite, wurtzite, christophite, greenockite, hauerite, oldhamite, and cinnabar, having $H = 2.5 - 4.0$; $v = 6 - 7$. Here also belong the red antimony sulphid, metastibnite,* and the arsenical sulphids, realgar and orpiment.

(9.) The tribe Proustoideæ includes the genus Pyrargyrites, under which we may include, in two subgenera, both the arsenical and the antimonial red silver ores, including proustite, pyrargyrite, miargyrite, etc.; with $H = 2 - 3$; $v = 8 - 9$. In this tribe also are included the arsenical and the antimonial forms of fahlerz as members of a genus, Tennantites, in which moreover are placed, binnite, dufrenoyite, livingstonite, etc., having $H = 3.5 - 4.5$; $v = 6.5 - 7.5$.

The following table gives a synoptical view of the tribes and genera above proposed for the order of the Metallata. Further studies may probably show reasons for further subdivision of some of these genera, and for the establishment of new ones.

* The native red sulphid of antimony, Sb_2S_3 , occurs abundantly as an amorphous deposit from thermal alkaline sulphurous waters, with sulphids of arsenic and cinnabar, at Steamboat Springs, Washoe county, Nevada, according to a private communication from Dr. G. F. Becker, who suggests the name of metastibnite.

Order METALLATA.

Suborder A. METALLOMETALLINEÆ.

- Tribe 1. METALLOIDEÆ (Metals, alloys, metallic Se and P).
 " 2. GALENOIDEÆ, including three subtribes :
 a. Thiogalenoideæ ; Thionites, Thiophyllites.
 b. Selenogalenoideæ ; Eucairites.
 c. Tellurogalenoideæ ; Tellurites, Tellurophyllites.
 " 3. BOURNONOIDEÆ ; Bournonites, Emplectites.
 " 4. PYRITOIDEÆ ; Pyrites, Pyritinus.
 " 5. SMALTOIDEÆ ; Smaltites, Algodonites.
 " 6. ARSENOFYRITOIDEÆ ; Arsenopyrites.

Suborder B. SPATOMETALLINEÆ.

- Tribe 7. SPATOMETALLOIDEÆ (Sulphur, non-metallic Se and P).
 " 8. SPHALEROIDEÆ ; Sphalerites.
 " 9. PROUSTOIDEÆ ; Pyrargyrites, Tennantites.

The writer has prepared tables, giving for each species in the order of the Metallata besides hardness, specific gravity and crystalline system, the chemical formula, represented by a simplified notation, as indicated in § 3, together with the unit-value for *p*, and the value of *v* calculated therefrom. For each species moreover, besides its trivial designation, are given its generic and specific Latin names. Thus, for example, we have for the species above named under the genus Pyrites ; *P. cubicus*, *P. prismaticus*, *P. cobalteus*, *P. niccolocobalteus*, *P. cuprocobalteus* and *P. rutheneus* ; while the named species of Pyritinus are ; *P. ferrosus*, *P. magneticus*, *P. manganeus*, *P. niccoleus*, *P. ferroniccoleus*, *P. cupreus*, *P. subcupreus* and *P. stanneus*. Again, the above-named species of the genus Sphalerites are ; *S. zinco vulgaris*, *S. zinco hexagonus*, *S. ferrozinco*, *S. manganeus*, *S. calcareus*, *S. mercureus* and *S. stibicus*. A similar task, except so far as regards generic and specific names, has already been accomplished for the order of the Silicates in the essay published in 1886, already cited, and is now well advanced for most of the other orders. When completed, the whole will be published with explanatory and critical details, as a Systematic Mineralogy, to be followed by a Descriptive Mineralogy.