ART. XVIII.—*A Suggestion for Mineral Nomenclature;* by HENRY S. WASHINGTON.

Introduction.—That the science of mineralogy may be regarded as a branch of descriptive chemistry (but one which deals only with substances occurring in nature) is recognized in the prevalent mineral classifications, where the chemical composition is the primary and most important factor. The character of the negative (acidic) ion controls for the formation of the largest classes, and subclasses may be based on the character of the positive (basic) ion, in some cases preceded by separation into anhydrous and hydrated compounds. In all these subclasses minerals which belong to the same acidic type are placed together. The ultimate smallest groups, which bring together minerals regarded as most closely related, are based on similarity in crystal form, dependent on isomorphous replacement, either entire or partial, and either in the negative or the positive portion of the molecule; while again dissimilarity in crystal form due to polymorphism of substances with the same empirical chemical composition, serves to distinguish between groups chemically alike.

The crystal form, therefore, is a necessary diagnostic, as important for the formulation of our idea of any mineral as its chemical composition. As Miers* expresses it, for the definition of minerals "we are forced to employ at least two properties, namely the chemical composition and the crystalline form: these two, when completely known, are necessary and sufficient for the definition and determination of any mineral." The less important characters, such as color, structure, habit, state of aggregation, and minor details of chemical composition, are (or should be) used only to distinguish very subordinate (varietal) divisions, and, as Miers justly says, far too much importance has been generally assigned to them in naming minerals. Many cases will also occur to every mineralogist of minerals which stand alone and can only be referred to indefinite positions in the classes, dependent on the general character of the negative ion; that is, they show no intimate relations with other minerals through both their chemical and crystallographic characters and constitute the sole representatives of potential groups, which thus correspond to the monotypic genera of botany and zoology.

In this necessary utilization of both chemical composition and crystallographic characters, the definition and classification of minerals differ from, and may justly be considered as in

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* H. A. Miers, Mineralogy, London, 1902, p. 2.

advance of, the classification and definitions of descriptive chemistry, which only take cognizance of the ultimate chemical composition of the substance as revealed by analysis, and its molecular structure as shown by its reactions, replacements, molecular weight, etc. To the chemist, $CaCO_3$ is only calcium carbonate, whether its crystal form is trigonal or orthorhombic, with correlated differences in specific gravity, optic characters, etc. To the mineralogist these two forms are different minerals, though the chemical composition is expressed by the same empirical formula.

This recognition of polymorphous or physically isomeric forms of the same empirical molecule as different substances and the converse relationship between substances of closely similar crystal form and of the same chemical type, though differing in composition through isomorphous replacement, is but a logical following out of the teachings of physical chemistry. It is an extension of the definition of "substance" to include, in addition to the chemical composition, the relations of the physical and chemical characters of matter to the conditions of equilibrium which control crystallization. That the recognition of the essential difference between substances (in this sense) with the same ultimate chemical composition is valid and necessary, is shown by consideration of such cases as diamond and graphite (C), pyrite and marcasite (FeS_2), or calcite and aragonite ($CaCO_3$). In these the differences in the physical characters, and to no less an extent in many of the chemical characters, as resistance to reagents, of the members of each pair are so great that they must be regarded as distinct substances. This would be true even from the purely chemical point of view, since the physical differences, especially those like specific gravity and specific heat, indicate differences in the molecular weight and very probably in molecular structure.

It may be noted here that among minerals there are few ascertained cases of chemical isomerism, in which the distinct physical and chemical characters, due to profound and persistent differences in the molecular structure, persist after the substance has been changed into an amorphous state, as by fusion or solution, and then recrystallized.* Numerous illustrations of this are furnished by organic chemistry, the most classical being that of urea and ammonium isocyanate. Among minerals it is difficult to prove the existence of such cases, though they unquestionably occur, and Groth† regards pyrite and marcasite, and cyanite, sillimanite and andalusite, respec-

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* Groth, Introduction to Chemical Crystallography, New York, 1906, p. 3.

† Groth, Chemische Krystallographie, Leipzig, Pt. I, 1906, p. 155, and Pt. II, 1908, p. 258.

tively, as cases in point. Whether there is any essential difference between physical and chemical isomerism may perhaps be doubted, but further discussion of this topic is uncalled for here.

In spite of this advanced state of the classification of mineralogy, the nomenclature is in much the same condition as in the time of Pliny, when minerals were named after their qualities, localities, or uses, with the systematic termination *-ites* or *-itis* (modern *-ite*), the only innovations being the introduction of names after persons and certain other arbitrary terminations. Despite attempts to introduce binomial names, analogous to those of botany and zoology, or those based on chemical characters, systematic mineralogy has adhered closely to the nomenclature of the first century A. D.*

As a consequence, mineral nomenclature, like that of the older rock classifications, is unable to express the facts of classification. Roots derived from names of places or persons can convey in themselves absolutely no idea of the mineralogical characters, and even those derived from chemical or physical characters are applicable to many different minerals. Thus cuprite applies equally well to CuO as Cu_2O, and octahedrite would be an appropriate name for magnetite, franklinite, or fluorite. All such name roots are purely arbitrary in their mnemonic connotations, but at the same time, by long association, a large proportion of mineral name roots convey very definite ideas of the mineral and chemical characters.

Again, with the uniform and monotonous general use of a single termination (-ite), and the arbitrary and unsystematic employment of others, the characters and relations of minerals, and even of mineral groups, are concealed. No distinction is evident from the name between a rare or uncharacteristic varietal form of a certain mineral (as hiddenite or sagenite), and a large mineral group which may include many distinct minerals (as zeolite or chlorite). In the case of a few of the commonest and largest groups of related minerals we have names, fortunately distinctive because of their terminations, which may be applied to the group as a whole, as spinel, feldspar, garnet, pyroxene, amphibole, mica; and the general usefulness and common application of these is sufficient evidence of the value of such group names. In other cases the difficulty of expressing relationships is got round and the need supplied by the word "group" after the name of a typical representative: as the pyrite, calcite, aragonite, olivine, and apatite groups. In all these group names the underlying idea which connects the members is adherence to a certain type of chemical formula, with isomorphous replacement, and, of equal importance, close

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* Cf. Dana, System Mineralogy, 1892, p. xl.

similarity in the crystal form as shown by the system, axial relations, and often cleavage. As regards the crystal system, in the largest groups this similarity need not amount to identity, as in the feldspars, pyroxenes and amphiboles, but in general the idea of a mineral group implies identity of crystal system modified only in its details by the slight morphotropic changes consequent on isomorphous replacement.

It will thus be seen that a mineral nomenclature should be able to express in the name a fairly definite idea of the chemical composition and type of compound, as well as the crystal system, and at the same time indicate the relations to other minerals, and especially the membership of a mineral in its particular "group." It is the object of this paper to lay stress on the importance of the recognition in mineralogical classification of this idea of mineral groups, distinguished by close similarity in chemical composition and crystal form, and made up of distinct mineral members, and to suggest a nomenclature which will express these relations, based on the general principles of chemical nomenclature, but providing also for the recognition of the crystal form as an element of the classification.

The System of Nomenclature.—As compared with the carbon compounds, minerals, and especially the silicates, present very great difficulties in the study of their molecular constitution. This is because of their high fusing points, non-volatility, insolubility, general chemical stability at ordinary or even very high temperatures (so that replacements of portions of the molecule are difficult), and impossibility of determination of the molecular weight, assuming that the term "molecular weight" is applicable to a solid body. Although we now realize the importance of this branch of mineralogy, and are beginning to recognize, especially among the silicates, the complex chemical constitution of many minerals and the existence of certain radicals or atomic groups analogous to those of organic chemistry, yet we are generally forced to be content with the expression of the chemical composition by simple empirical formulas. The constitutional and graphic formulas of but very few minerals can be given with any degree of confidence, and in the vast majority of cases we are absolutely in the dark.

Mineralogy is essentially in the condition of organic chemistry of the early days, when the composition of alcohol could only be expressed empirically as C_2H_6O, that of lactic acid as $C_3H_6O_3$, and that of urea as CH_4ON_2; whereas at present we can confidently express them by the constitutional formulas, $(C_2H_5)(OH)$, $(CH_3)(CHOH)(COOH)$, and $(CO)(NH_2)_2$, systematically known as ethyl alcohol, α-hydroxypropionic acid, and carbonyl amide, the last differing in constitutional formula from the isomeric ammonium isocyanate, $(CON)(NH_4)$.

Indeed, the theory of mineral constitution at present is in many ways analogous to the "theory of types" in organic chemistry, formulated by Gerhardt about 1850, as is seen in the general reference of the silicate minerals to simple silicic acids, H_2SiO_3, H_4SiO_4, $H_2Si_3O_7$, etc. Kekulé's "theory of linked atoms" has now superseded this in organic chemistry,[*] and the applicability of this to mineral chemistry has only recently begun to be realized.

The study of the molecular constitution of minerals and attempts at the establishment of constitutional formulas have been undertaken by Tschermak, Groth, Clarke, and many others, either through direct experiment or study of alteration products, but so far with doubtful success in most cases, and it will probably be many years before mineralogy attains to the knowledge requisite for formulas like those of modern organic chemistry.

In three important papers Penfield[†] established the complex character of the acidic portion of the tourmalines and amphiboles, and showed the effect of the mass action of the complex acid in controlling crystallization, allowing replacement of the hydrogen atoms of the hypothetical acid by very different elements or radicals, and with different valences, but without change in crystal form. He also speaks of these acids as tourmaline acid and amphibole acid, with the implication that an essential character of their salts is adherence to the particular crystal form of tourmaline and amphibole respectively.

More recently the problem of the constitution of some silicates has been studied by Tschermak, Baschieri and others.[‡] These investigators have identified certain silicic acids, which they call after the mineral names, among them being: anorthitic acid (H_2SiO_3) albitic acid ($H_2Si_3O_7$), leucitic acid ($H_4Si_2O_6$), heulanditic acid ($H_{10}Si_6O_{17}$), granatic acid ($H_4Si_3O_8$ and datolitic acid ($H_2Si_2O_5$). Their method, it may be remarked, does not apparently permit of discrimination between a purely silicic or an alumo- or boro-silicic acid, and none of these workers suggests, like Penfield, that the acid or the acid name implies the crystal form of its salts.

It is suggested here that this concept of Penfield of silicate minerals as salts of mineral acids, in many cases of much greater complexity than is implied by the empirical formula, with the implication of the adherence of the salts to a charac-

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[*] Cf. C. Schorlemmer, Rise and Development of Organic Chemistry, London, 1894, pp. 39, 69, and 155.

[†] This Journal, vii, p. 97, 1899: x, p. 19, 1900; xxiii, p. 23, 1907.

[‡] Tschermak, Sb. Ak. Wiss. Wien, cxii (1), p. 355, 1905, cxiv (1), p. 455, 1905, cxv (1), p. 217, 1906. E. Baschieri, Proc. verb. Soc. Tosc., xvi, p. 34, 1907; Atti Soc. Tosc. Mem., xxiv, p. 133, 1908. Himmelbauer, Sb. Ak. Wiss. Wien, cxv (1), p. 1184, 1906.

teristic crystal form, be extended to minerals in general and made the basis of a mineral nomenclature. From this point of view silicate minerals would not be considered simply as salts of orthosilicic acid (H_4SiO_4), metasilicic acid (H_2SiO_3), disilicic acid ($H_2Si_2O_5$), and so forth; as substitution derivatives of normal aluminum silicates according to Clarke, (which correspond to the old theory of types); or of multiples of silica according to Goldschmidt: but each group would be considered as salts of a particular silico- or alumino-silico- acid characterized by the particular crystal form and symmetry of its salts, and capable of ismorphous replacement either of its basic hydrogens or in the acidic portion.

This concept may be most appropriately applied to mineral groups, distinguished as at present by identity of chemical type and close similarity in crystal form, but it may be equally well applied to monotypic "groups", represented, so far as now known, by only one mineral and which exhibit no evident near relationships, either chemical or crystallographic, as is the case with beryl and calamine. It is also clear that it would be applicable to minerals of simple as well as highly complex constitution. A further point, and one of great importance, is that a system of nomenclature based on this concept would be applicable whether the structural or constitutional formula, or even the exact chemical composition, of the mineral acid were known or not, as the salts of a given mineral acid (in this sense) would be identifiable and their relationship established by their conforming to a certain empirical chemical formula and crystal form. Thus the various pyroxenes and amphiboles are members of two different, but well-characterized, and universally recognized "natural" groups, though we are as yet almost wholly ignorant of their molecular constitution, knowing only that they may be referred, but do not necessarily belong, to the metasilicates, but are undoubtedly much more complex than is indicated by the empirical formulas. We cannot even determine which group is the more complex.

Such a nomenclature would be rational and would be analogous to that of inorganic chemistry, of which mineralogy may be considered to be a branch, except that the crystallographic character is implied in the name and is an integral part of the definition. It might even be suggested that such a nomenclature as is here suggested is also applicable to artificial salts, and would be found especially useful with such highly complex compounds as the silicotungstates, phosphomolybdates, cobalt-ammine compounds, the various groups of which might be named after chemists who have been especially identified with their study.

While in advance of the present inadequate nomenclature, in that not only chemical and crystallographic characters but mineral relationships would be indicated, the suggested nomenclature would not, nor is it intended to, replace this for general use. The two would exist simultaneously, though used for different purposes, as the new nomenclature would lend itself readily to, and would probably aid in, the study and investigation of the molecular constitution of minerals and in other ways. In ordinary parlance and for usual purposes minerals, especially the common ones, would go by their present names, while when greater precision and exactitude were needed, especially in theoretical discussion, the suggested nomenclature could be used. Similarly, in inorganic and especially in organic chemistry, the common names are ordinarily used instead of the longer and more complex scientific names, which are systematic and indicate the chemical constitution.

For the purposes of such a nomenclature the large store of present mineral names may be drawn on for the necessary roots, since these roots would have in most cases sufficient mnemonic connotations to give directly an idea of the general chemical and crystal characters. Well-known or fairly well-known roots are sufficiently numerous to cover nearly the whole field of mineralogy. Though new minerals are being discovered with some frequency, representatives of entirely new mineral groups are comparatively rare, as many of the new minerals are referable to groups already known, and with increasingly exact knowledge of chemical composition and molecular structure, many minerals of hitherto unknown or uncertain affinities are being correlated with other groups, as the sodalites and the garnets.

It is suggested that the names of minerals (excepting for the present the elements and hydrocarbons) be formed similarly to those of oxides and salts in inorganic chemistry, as ferric oxide, sodium chloride, potassium sulphate, but with the crystal character implied in the name. Such mineral names will be binomial in general, composed of one term denoting the basic (positive) portion of the molecule and another denoting the acidic (negative) portion. As the acidic portion is of major importance in classification it will be considered first.

The name of the mineral acid, or the acidic portion of its salts, will imply not only general chemical composition and type, but the crystal symmetry and general crystallographic relations of its salts, subject to the morphotropic changes due to isomorphous replacement.

The acid (*negative*) *radical* of a mineral group will be denoted by a root derived from the present name of a typical and appropriate member, preferably that best known or first named. To this root, in general shorn of its present termination (except for euphony or to avoid confusion with ordinary chemical salts), will be affixed the termination used in inorganic chemistry for the type of compound represented. For the mineral acid itself this termination would then be *-ic*, for a binary compound (oxide, sulphide, etc.) it will be *-ide*, for the sulpho-acid and analogous salts,* and for the oxy-acid salts, it will be *-ate*. As noted above, it will not be necessary to know the constitutional formula of the acid or mineral group to name it, as it may be defined by its empirical formula and crystal form.

The water of crystallization of hydrated mineral salts may in general be considered for the purposes of nomenclature as part of the negative portion of the molecule, since not only do nearly all hydrates differ crystallographically from the anhydrous salts, but the crystal form varies with the number of molecules of water present when several hydrates exist.

Such simple designations, implying always the crystal system characteristic of the salts of the mineral acid, will suffice for the negative (acidic) portion of isomorphous mineral groups in which the acid radical is identical in all (the base alone varying through isomorphous replacement), or for monotypic mineral groups. Thus, the members of the calcite, aragonite, and olivine groups are respectively salts of calcitic, aragonic, and olivinic acids, or calcitates, aragonates, and olivinates; while cyanite and calamine are the only known disthenate and calamate respectively.

When, however, in a group the chief element in the acidic portion is replaceable isomorphously, by different elements, as with the pyrite and apatite groups or, as in the pyroxenes and feldspars, there are marked differences in the crystal symmetry, the acidic portion remaining chemically the same, it becomes necessary to indicate these differences in the nomenclature. This may best be done in two ways, according to which of the cases is involved.

In the case of isomorphous replacement in the acidic portion the different compositions may be expressed by the use of appropriate prefixes to the acidic term used without a hyphen. Thus all members of the pyritohedrally isometric pyrite group would be pyrides, but pyrite and hauerite would be sulpyrides, and smaltite and chloanthite arsenpyrides. Among the silicates the presence of unusual or non-typical elements partially replacing silica may be expressed by similar syllables prefixed to the acidic name with a hyphen. Thus rosenbuschite and lavenite would be zirco-diopsidates. In some cases, when the isomorphous replacement in the acidic portion is complex, it may be advisable to use very much shortened syl-

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* The regular termination *-ite* would be inadvisable for these, as liable to confusion with present names.

labic forms for the various elements, as will be explained when the naming of the base is considered.

In the case of the more complex mineral acids, especially among the silicates, as the alumo-silicates or boro-silicates, in which only the subsidiary acidic element is isomorphously replaceable, the replacement will be indicated by the use of appropriate chemical syllables prefixed to the acidic term, used with a hyphen. Thus, if the garnets are regarded as salts of complex alumo-. etc.- acids, they would be called alumi-garnetates, ferri-garnetates, and chromi-garnetates, and similarly members of the datolite group would be bori-datolates, alumi-datolates or yttri-datolates, represented by datolite, euclase, and gadolinite. This will serve to distinguish such complex salts from those of mineral acids in which one characteristic element exists and is wholly replaced, as in the apatite group, which would be called phosphapatates, arsenapatates, and vanadapatates.

When the differences are those of crystal symmetry, as in the pyroxene and feldspar groups, the general group names will be formed as above by a root derived from the present group name or best representative, followed by the terminations *-oic* for the acid, *-ode* for binary compounds, and *-ote* for sulpho- and oxy-salts. The various subgroups, distinguished by differing but related crystal systems, will be designated by the use of the appropriate roots and regular terminations as described above. Thus all the members of the pyroxene group would be salts of pyroxenoic acid or pyroxenotes, while the orthorhombic members would be hypersthenates, the monoclinic diopsidates, and the triclinic rhodonates.

The rare cases among minerals of homologous series, corresponding to the paraffins and olefines of organic chemistry, in which each member differs from the preceding by a constant increase of a certain atomic group, must also be considered. These are best represented by the humite group, better called "series." The members of such a series may be designated as to the acidic portion by the use of the prefixes *uni-*, *bi-*, *ter-*, etc., to indicate the number of the varying radical, as will be shown later.

The base or bases present will be indicated by the use of the name or names of the positive element or elements, either as such or expressed by appropriate syllables when more than one base is present. It may be suggested that the relative importance of the several isomorphous bases present be indicated by a definite order in the syllables and that the most important be placed last, the preceding ones being in the nature of modifiers. This can also be emphasized by using the full name for the most important base, and a contracted adjectival form, ending in *i* or *o*, for the others. When two bases are of equal importance, present in about equal molecular amounts, the combined full names may be used, though this last might better be reserved for definite double salts, as dolomite. Illustrating the above idea, forsterite would be called magnesium olivinate, most chrysolite ferro-magnesium olivinate, hyalosiderite might be magnesi-ferrous olivinate, and fayalite ferrous olivinate.

In many minerals, however, several bases are present and in these cases, and even when there are only two, the designation of the base may become long and cumbrous. It may therefore be desirable to have all the bases represented by syllables as compact and condensed as possible, so long as this can be done without sacrificing clearness. For this purpose it is suggested that the first syllable of the element name may be used, joined together without linking vowels or hyphens, the order being significant of the relative importance, as above. Thus enstatite would be magnesium hypersthenate, bronzite fermag hypersthenate, and a highly ferrous hypersthene magfer hypersthenate.

With the increasing recognition of the presence of radicals in minerals it becomes necessary, as a matter of convenience, to designate these by short terms, and here we may well follow the lead of organic chemistry, where we find such indispensable radical names as ethyl, butyl, phenyl, acetyl, derived from their most prominent compounds. Similarly we might designate the mineral radical, $Al(F,OH)$, essential in topaz, as topyl; $Mg(F,OH)$, present in the chondrodrite series, as chondryl; and (BOH), which Penfield has shown to be present in tourmalines, as tourmyl. Such radical names would take the place of element names when present as bases.

The objection will, of course, be raised against the use of such syllables that they are barbarous, uncouth, and cacophonous. In reply to this it may be said that, while they will undoubtedly appear so at first, usage will gradually render them easy, natural, and less awkward. As a case in point may be cited the terminology of organic chemistry, where we find such words as carboxyl, aldoxim, azoxybenzol, glyoxal, phthalisoimide, and a host of others. The same objections could have been, and probably were, raised against these, but to express the lengthy and complicated names of organic compounds the chemist has found such syllables absolutely necessary. They are readily understandable and give an immediate insight into the composition of the substance, have wholly lost their original "barbarousness," and new ones are freely coined when needed.

Acid and basic salts present some difficulties, as it is not always possible as yet to determine the function of hydrogen or hydroxyl in minerals. When definitely known to be basic or acid salts they may be so designated, but in general they may be designated by special acidic names for the group, since the acidity or basicity almost always determines a crystal form different from that of the normal salt.

Names formed as suggested above have certain analogies with some of the present mineral names, in which isomorphous replacement is indicated by the use of chemical modifiers, as soda-microline, manganopectolite, cuprodescloizite, natrojarosite, plumbo-jarosite and soda-mica. Even in these we can see the lack of system in present nomenclature, since these names belong to two distinct categories. In the one the modifier expresses only partial replacement of the characteristic element of the type mineral by an isomorphous one, as in the first three examples, which are presumably cases of solid solution and should be regarded as varieties of the type, or as intermediate between two extremes. In the last three cases there is *entire* replacement by the element denoted in the name, and such minerals are definite compounds and must be regarded as distinct species. For this reason natrojarosite and plumbojarosite are better entitled to recognition as distinct minerals than are soda-microcline (anorthoclase) or manganopectolite, and should have special names not formed on this plan, while paragonite has properly replaced the earlier soda-mica, which last should be used for a mica in which the potassium is only partially replaced by sodium.

The names of the suggested nomenclature are properly applicable only to minerals of the second kind just mentioned, that is to definite compounds, since it is essentially an inorganic chemical nomenclature, in which mixed crystals should be named by calling them mixtures of their components. In mineralogy the case is somewhat different, it is true, as such mixed crystals are often important and fairly well-defined mineral species, and names for them are necessary. Some latitude and discretionary power must, therefore, be allowed, and while all rather indefinite mixed crystals need not receive specific recognition or names, there will be many cases, especially when the mixture is of mineralogical importance, fairly constant in composition, or with some approximation to simple stoichiometric ratios, when names as above should be bestowed. To meet the common case of the indefinite or variable isomorphous replacement, it may be suggested that the syllable *-ic* be added to the compounded elemental syllables used for the base. Thus the various hypersthenes and bronzites would be called collectively fermagic hypersthenates, and the lime-soda feldspars would be calsodic albates.

Illustrations of the System.—It is impracticable to give here a complete illustration of the application of the system to all known minerals, so that only a few selected cases are given which will illustrate the points brought out above. It is purposed to publish elsewhere a fairly complete list, already prepared, which will serve as a basis for the suggested nomenclature.

SPHALERITE GROUP.

Sphalerides, $R''(S,Se,Te)$, isometric, tetrahedral.

Sphalerite, ZnS	Zinc sulsphaleride
Metacinnabarite, HgS	Mercury sulsphaleride
Alabandite, MnS	Manganese sulsphaleride
Tiemannite, $HgSe$	Mercury selsphaleride
Onofrite $Hg(S,Se)$	Mercury selsulsphaleride
Coloradoite, $HgTe$	Mercury telsphaleride

PYRITE GROUP.

Pyrides, $R(S,As,Sb)_2$, isometric, pyritohedral.

Pyrite, FeS_3	Iron sulpyride
Hauerite, MnS_2	Manganese sulpyride
Laurite, RuS_2	Ruthenium sulpyride
Smaltite, $CoAs_2$	Cobalt arsenpyride
Chloanthite, $NiAs_2$	Nickel arsenpyride
Sperrylite, $PtAs_2$	Platinum arsenpyride
Cobaltite, $Co(S,As)_2$	Cobalt sularsenpyride
Gersdorffite, $Ni(S,As)_2$	Nickel sularsenpyride

MARCASITE GROUP.

Marcasides, $R(S,As)_2$, orthorhombic.

Marcasite, FeS_2	Iron sulmarcaside
Löllingite, $FeAs_2$	Iron arsenmarcaside
Safflorite, $CaAs_2$	Cobalt arsenmarcaside
Rammelsbergite, $NiAs_2$	Nickel arsenmarcaside

HEMATITE GROUP.

Hematides, R_2O_3, trigonal.

Corundum, Al_2O_3	Aluminum hematide
Hematite, Fe_2O_3	Iron hematide
Ilmenite, $(Fe,Ti)_2O_3$	Titanferri hematide
Geikielite, $(Mg,Ti)_2O_3$	Titanmagnesi hematide
Pyrophanite, $(Mn,Ti)_2O_3$	Titanmangani hematide

If the members of this group are considered to be aluminates, ferrates, etc., the appropriate names would be: Aluminum alhematate, iron ferhematate, iron titanhematate, magnesium titanhematate, and manganese titanhematate.

CALCITE GROUP.

Calcitates, R''_2CO_3, trigonal.

Calcite, $CaCO_3$	Calcium calcitate
Magnesite, $MgCO_3$	Magnesium calcitate
Dolomite, $CaMg(CO_3)_2$	Magnesicalcium calcitate
Ankerite, $(Mg,Fe)Ca(CO_3)_2$	Fermag-calcium calcitate
Siderite, $FeCO_3$	Ferrous calcitate
Rhodochrosite, $MnCO_3$	Manganese calcitate

FELDSPAR GROUP.*

Feldspathotes, $\left\{ \begin{matrix} R'AlSi_3O_8 \\ R''Al_2Si_2O_8 \end{matrix} \right\}$, monoclinic-triclinic.

ADULAR SUBGROUP.

Adularates, monoclinic.

Orthoclase, $KAlSi_3O_8$	Potassium adularate
Barbierite, $NaAlSi_3O_8$	Sodium adularate
Celsian, $BaAl_2Si_2O_8$	Barium adularate

ALBITE SUBGROUP.

Albates, $R'AlSi_3O_8$, triclinic

Microcline, $KAlSi_3O_8$	Potassium albate
Albite, $NaAlSi_3O_8$	Sodium albate
Anorthoclase, $(K,Na)AlSi_3O_8$	Potassisodium albate

ANORTHITE SUBGROUP.

Anorthates, $R''Al_2Si_2O_8$, triclinic.

Anorthite, $CaAl_2Si_2O_8$	Calcium anorthate
Carnegieite, $Na_2Al_2Si_2O_8$	Sodium anorthate

Mixed Salts.

Oligoclase, Ab_2An_1	Caldisod anorth-albate
Andesine, Ab_1An_1	Sodcal alb-anorthate
Labradorite, Ab_1An_2	Soddical alb-anorthate

PYROXENE GROUP.

Pyroxenotes, $\left\{ \begin{matrix} R''_2Si_2O_6 \\ R''R'''_2SiO_6 \end{matrix} \right\}$, orthorhombic, monoclinic, triclinic.

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* The constitution and relations of the feldspars, lenads and zeolites will form the subject of a subsequent paper.

Hypersthene Subgroup.

Hypersthenates, orthorhombic.

Enstatite, $Mg_2Si_2O_6$	Magnesium hypersthenate
Bronzite, $(Fe,Mg)_2Si_2O_6$	Ferromagnesium hypersthenate
Hypersthene, $(Mg,Fe)_2Si_6O_2$	Magnesiferrous hypersthenate

Diopside Subgroup.

Diopsidates, monoclinic.

Diopside, $CaMgSi_2O_6$	Calcimagnesium diopsidate
Hedenbergite, $CaFeSi_2O_6$	Calciferrous diopsidate
Wollastonite, $Ca_2Si_2O_6$	Calcium diopsidate
Augite, $\left\{\begin{array}{l} m\mathrm{CaMgSi_2O_6} \\ n\mathrm{(Mg,Fe)(Al,Fe)_2SiO_6} \end{array}\right.$	Alfercalmag diopsidate
Acmite, $NaFeSi_2O_6$	Ferrisodium diopsidate
Jadeite, $NaAlSi_2O_6$	Alumisodium diopsidate
Spodumene, $LiAlSi_2O_6$	Alumilithium diopsidate
Pectolite, $HNaCa_2Si_3O_9$	Acid sodicalcium diopsidate

Rhodonite Subgroup.

Rhodonates, triclinic.

Rhodonite, $Mn_2Si_2O_6$	Manganese rhodonate
Babingtonite, $\left\{\begin{array}{l} m\mathrm{(Ca,Fe)_2Si_2O_6} \\ n\mathrm{Fe_2Si_3O_9} \end{array}\right.$	Ferricalcium rhodonate

Olivine Group.

Olivinates, $R''_2Si_2O_4$, orthorhombic.

Forsterite, $Mg_2Si_2O_4$	Magnesium olivinate
Monticellite, $CaMgSi_2O_4$	Calcimagnesium olivinate
Chrysolite, $(Fe,Mg)_2Si_2O_4$	Ferromagnesium olivinate
Fayalite, $Fe_2Si_2O_4$	Ferrous olivinate
Tephroite, $Mn_2Si_2O_4$	Manganous olivinate
Glaucochroite, $CaMnSi_2O_4$	Calcimanganous olivinate

Chondrodite Series.

Chondrodates, $R''_{2n-1}(R''(F,OH))_2(SiO_4)_n$, orthorhombic

Prolectite, $Mg(Mg(F,OH))_2(SiO_4)$	Magnesium uni-chondrodate
Chondrodite, $Mg_3(Mg(F,OH))_2(SiO_4)_2$	Magnesium bi-chondrodate
Humite, $Mg_5(Mg(F,OH))_2(SiO_4)_3$	Magnesium ter-chondrodate
Leucophœnicite, $Mn_5(MnOH)_2(SiO_4)_3$	Manganese ter-chondrodate
Clinohumite, $Mg_7(Mg(F,OH))_2(SiO_4)_4$	Magnesium quadri-chondrodate

Datolite Group.

Datolates, $R''_3R'''_2Si_2O_{10}$, monoclinic.

Datolite, $H_2Ca_2B_2Si_2O_{10}$	Acid calcium bori-datolate
Euclase, $H_2Gl_2Al_2Si_2O_{10}$	Acid glucinum alumi-datolate
Gadolinite, $FeGl_2Y_2Si_2O_{10}$	Ferro glucinum yttri-datolate
Homilite, $FeCa_2B_2Si_2O_{10}$	Ferro calcium bori-datolate

Spinel Group.

Spinelates, $R''R'''_2O_4$, isometric.

Spinel, $MgAl_2O_4$	Magnesium alumispinelate
Hercynite, $FeAl_2O_4$	Ferrous alumispinelate
Gahnite, $ZnAl_2O_4$	Zinc alumispinelate
Magnetite, $FeFe_2O_4$	Ferrous ferrispinelate
Chromite, $FeCr_2O_4$	Ferrous chromispinelate

Apatite Group.

Apatates, $R''_5(F, Cl)((P, As, V)O_4)_3$, hexagonal.

Apatite, $Ca_5(F,Cl)(PO_4)_3$	Calcium phosphapatate
Pyromorphite, $Pb_5Cl(PO_4)_3$	Lead phosphapatate
Mimetite, $Pb_5Cl(AsO_4)_3$	Lead arsenapatate
Svabite, $Ca_5F(AsO_4)_3$	Calcium arsenapatate
Vanadinite, $Pb_5Cl(VO_4)_3$	Lead vanadapatate

Locust, N. J., November, 1911.