International agreement in mineralogical and crystallographical nomenclature.

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A COMMITTEE on Nomenclature and Classification of Minerals was appointed at the first annual meeting of the Mineralogical Society of America in December 1920, and two of its reports have been recently issued in the 'American Mineralogist'[2]. Such a committee for standardizing nomenclature is clearly needed, but it must take a far wider view. If the recommendations can be, or are likely to be, adopted only in their country of origin then the result will be still further confusion in the nomenclature of the science. It is especially important in this connexion to bear in mind that science is world-wide, and its language should, as far as possible, be adapted to meet international needs. The tendency to adapt names to particular languages should rather be discouraged. For example, Kalzit (for Calcite) in German, particularly in Austria; Esfena, Esfalerita, &c. (for Sphene, Sphalerite, &c.) in Spanish; Ematite and Alite (for Hematite and Halite) in Italian; Toryanit (for Thorianite) in Polish.

What is really wanted is an international committee, or at least some co-ordination between the Mineralogical Societies of different countries. Rather than by drawing up hard and fast rules bearing on priority,[3] the

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[1] This paper was also read on August 8, 1924, before Section C (Geology) at the Toronto meeting of the British Association for the Advancement of Science. Title only is published in the Report. I further had the advantage of discussing it informally with several American mineralogists, more particularly at the Geophysical Laboratory in Washington.

[2] Amer. Min., 1923, vol. 8, p. 51; 1924, vol. 9, p. 61.

[3] Strict adherence to priority would give rise to many difficulties. For example, the now well-known name Calcite was first applied (in 1836) to the 'barley-corn' pseudomorphs of calcium carbonate after celestine from Sangerhausen in Thuringia; and only later (in 1843) was it limited to the species then known as Calc-spar, Calcareous spar, or Iceland-spar.

forms and terminations of names, &c., more service would be rendered by a mutual understanding, involving some 'give and take', in order to arrive at the best names and terms for international use.

The names of the native elements must naturally remain for each language. Unless, perhaps, the Latin equivalents universally used for the chemical symbols, e. g., Aurum, Argentum, Cuprum, &c., were by common consent adopted. But such names as Copper-pyrites, Kupferkies, Cuivre pyriteux, Kopparkis, Cobre amarillo, Rame giallo, &c., might very well give place to Chalkopyrite; and Copper-glance and Kupferglanz to Chalkosine (Chalcocite). Fluor, Fluor-spar, Fluorine (French), Fluss, Flußspat might be Fluorite in all languages. And many other simple changes of a similar kind might be suggested.[1]

A case that easily leads to confusion and often to error is when the same name is applied in different languages to different mineral-species. For example, Magnesite is used by French authors and some Germans for the silicate Meerschaum (or Sepiolite), whilst in most other languages it denotes the carbonate of magnesium. The Felspar[2] Labradorite is known in French and often also in German as Labrador: whilst in French Labradorite is a Felspar-basalt, and in Russian a Felspar-gabbro (anorthosite). The zeolite Phillipsite is called Christianite by the French (their Phillipsite being Bornite or Erubescite); and Stilbite is called Desmin in Germany (their Stilbit sometimes being Heulandite). The well-known and hopeless confusion in the names Calamine[3] and Smithsonite leads to many errors. Many other examples might be cited.

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[1] A useful but little-known book is C. Keferstein's 'Mineralogia polyglotta' (Halle, 1849).

[2] More correctly Feldspar, as fully explained in the Oxford Dictionary, and as always used in America; Feldspath (French), Feldspat (German).

[3] Calamine (Lapis calaminaris) was used by Pliny for zinc-ores in general and also for the zinc oxide from furnaces. The changes in the name are traced below:

Author.	Carbonate ($ZnCO_3$).	Hydrous silicate $H_2Zn_2SiO_5$.
J. Smithson, 1803 (followed by J. D. Dana, 1837–1850).	Calamine	Electric Calamine.
A. Brongniart, 1807	Zinc carbonatée	Calamine.
F. S. Beudant, 1832 (followed by J. D. Dana, 1854–1892).	Smithsonite	Calamine.
H. J. Brooke and W. H. Miller, 1852 (followed by W. J. Lewis, 1899).	Calamine	Smithsonite.
A. Kenngott, 1853	Smithsonite	Hemimorphite.

Clearly, the best course now is to follow Kenngott.

If mineralogists were all agreed on the name Autunite (from Autun in France) for Calcouranite or Kalkuranit, then French authors would perhaps be willing to give up Chalcolite (so easily confused with Chalcocite) for Torbernite; and if Chessylite (from Chessy) were generally adopted in place of Azurite, they might be persuaded to make some other small concession. As a concession to the Germans, the old and well-known names Meerschaum, Blende, and Mispickel might very well be adopted.

The correct pronunciation of the names so adopted for general use need not be considered seriously. Even quite simple names like Pyrite, Quartz, Calcite, &c., are pronounced very differently in different countries. International usage depends mainly on the printed word (in Roman characters) and it is in this that standardization is needed. If a name with a derivation peculiar to one language is changed, with a mistaken idea of adapting it to some other language, then confusion will follow and the name may be lost in an alphabetical index. For example, the Swedish name, Åkermanit may be altered to Åkermanite or even Akermanite, but never to Ackermanite, Akermannite, Okermanite, or Oakermanite.

This leads to the difficulty presented by the diacritical marks peculiar to various languages. Here there may be a difficulty not only in the form of the word, but also in its alphabetical arrangement, and for the majority of printers in the lack of the proper type. In the Swedish alphabet å, ä, and ö find a place after z; and the same for the Danish and Norwegian æ, ø or ö. The German ö is sorted sometimes with o and sometimes with oe, both ways being used in German indexes; whilst in Hungarian ö and ő both come after oz. In Polish ó comes after oz, ź after zz, and ż after źź. In Bohemian ž comes after zz, and č after cz, but ch after h, whilst in Spanish ch comes after cz. Diacritical marks have such varied meanings in different languages (e.g. coöperate and zoölogy in America, ô and ō in Japanese, ô in French; Liége or Liège in French) that for international use they are better ignored so far as alphabetical arrangement is concerned. Unless they can be printed correctly, they are better omitted; while any attempt to acquire the correct pronunciation of the original language is only pedantic. The Hungarian name Felsőbányit is invariably printed incorrectly as Felsöbanyite, and still more so as Felsoebanyite. Similarly, Baeckstroemite is quite incorrect for the Swedish Bäckströmit.

The question of the alteration of the form of names with the idea of adapting them to different languages resolves itself into whether

(i) the correct pronunciation, or (ii) the correct spelling of the printed word, is the more important. For international science the latter is surely to be considered first. When giving new mineral names, authors should have some consideration for the foreigner. For example, the English Whewellite and the Czech Vrbaite (see this vol. p. 273) must present difficulties in most other languages.

Unless obviously in error, species names should be accepted in as nearly as possible the same form as that given by the first author. If they are to be adapted to specially suit every language, unnecessary confusion will only follow. As an example, take the two names Kainosite and Kainite, originally given in Swedish and German in the forms Kainosit and Kainit respectively, and both derived from the Greek *καινός*, new. The first was altered by Dana (1892) to Cenosite, which is scarcely recognizable even in English; whilst for the second the strictly German spelling Kainit is usually adopted in the trade for this potash salt. The term Kainozoic (Cainozoic, Cænozoic, Cenozoic) for a geological period has the same derivation, and for international use the Greek form of the word should be adopted. Or again, such a name as Akrochordite, recently given in Swedish from the Greek *ἀκροχορδών*, a wart, should be allowed to stand in that form. To alter it to Acrochordite is only causing international difficulties. Nothing is gained, only confusion, by unnecessarily changing names in this way. There is no real need to change the Greek *κ* to c in English, and still less to pronounce it as s (as in cinema). The forms pinakoid and pyknometer are preferable to pinacoid and pycnometer.

The transliteration of Russian names presents a special difficulty. International agreement would here seem to be impossible. A Czech system of transliteration was devised in 1900 for use in the International Catalogue of Scientific Literature, but for general use this presents typographical difficulties. There are already several systems in use for transliteration into English, and any one adopted must be more or less arbitrary. For uniformity in spelling, a system that would work both ways would be required; while for indicating the pronunciation, different systems would be required for different languages. The Russian ч is transliterated ch in English, tsch in German, tch in French, and č in Czech; and the Russian в as v in English, w in German, and ff in French. But there is a sad lack of uniformity even in the same language. For example, for the Tschewkinit of G. Rose, 1839, German authors have mostly used the mixed German and French form Tscheffkinit, whilst French authors have usually taken the German form Tschewkinite.

An English transliteration of the Russian Чевкинитъ would be Chevkinite. The Russian Тюямунитъ (in modern Russian Тюямунит) has been transliterated Tyuyamunite, Tĭujamunite, Tuyamunite, Tüjamunit, Tjujamunit, Tjuiamunit (see this vol. p. 287).

While Russian names present a difficulty in English, on the other hand, English names present a difficulty in Russian, e.g. such names as Woodwardite, Whewellite, Howlite, &c. By transliterating certain names into Russian according to one system and transliterating them back again into Roman characters according to another system, some strange mineral transformations have resulted, for example:

Ankylit (from ἀγκύλος) → Ancylite → Ансилитъ → Ansilit.[1]
Hibschite → Гибшитъ → Gibshite → Gibbsite.[2]
Howlite → Хаулитъ → Khaulite.
Whewellite → Вевеллитъ → Vevellite → Wavellite.

Although specially advocated by Dana[3] and pushed to the extreme by the American Committee on Nomenclature, there is no special virtue in the termination *-ite* for mineral names. It is used in so many senses that a word with this ending does not necessarily suggest a mineral name. The Oxford Dictionary devotes two columns to its explanation with many examples. Complete sentences of words ending in *-ite* can be constructed—Exquisite parasite expedite appetite, bite white mite opposite. There is a common tendency nowadays to invent fancy trade-names ending in *-ite* for explosives, building materials, and all sorts of manufactured goods—dynamite, stiktite, shine-a-lite, cigarlite, quickrite, orlrite. Thousands of such names are now in use. For good-sounding mineral names, Rutile, Anatase, Epidote, Xenotime, Spodumene are hard to beat. To provide these with a double termination, e.g. Xenotimite, Spodumenite, is quite absurd.

A move in the opposite direction has been made by altering the established name Metacinnabarite to Metacinnabar, in order to conform

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[1] Zeits. Kryst. Min., 1906, vol. 51, p. 184; Min. Mag., 1907, vol. 14, p. 394.

[2] Journ. Chem. Soc. London, 1910, vol. 98, Abstr. ii, p. 137.

[3] An excellent conspectus of mineralogical nomenclature was given by J. D. Dana in the introduction to the fifth edition (1868) of his 'System of Mineralogy'; and in that edition many names were for the first time provided with the termination *-ite*. For example, Analcite, Nephelite, Pyrrhotite, Chalcocite; but of these the older forms, Analcime, Nepheline, Pyrrhotine, Chalcosine, still stand in all European languages. Dana also attempted to establish a distinction between mineral names and rock names by the use of the terminations *-ite* and *-yte* respectively. The latter has found little or no acceptance.

with Cinnabar. But this creates less difficulty than the new German spelling Metazinnabarit.

I do not intend to suggest that the termination *-ite* should be dropped, and far from it that fancy terminations should be invented for future mineral names. I only think it a mistake to obliterate ruthlessly the terminations of those names that have already become established.

The following trial list of some of the more common mineral names has been drawn up as a basis for discussion. An attempt has been made to select such names that will be acceptable to the majority. The selection is of course more or less arbitrary, and it is not always easy to avoid national and personal prejudices. If such a list of names were by common consent adopted by the Mineralogical Societies of England, France, Germany, and America, and by the editors of some few journals, the selected names would, I think, soon come into general use.

Analcime (R. J. Haüy, 1797), as in all European languages. Only in America is Dana's (1868) form Analcite in general use.

Anatase (R. J. Haüy, 1801), as used in England, France, and Germany, and by Dana (1837–1854). Octahedrite (H. B. de Saussure, 1796) was revived by Dana in 1868 ; but this name is now applied to a group of meteoric irons.

Argentite (W. Haidinger, 1845) = Argyrose, Argyrite (Fr.), Silberglanz (Germ.).

Autunite (H. J. Brooke and W. H. Miller, 1852) = Calcouranite, Kalkuranit.

Baryte (R. Kirwan, 1784, Min., p. 5, Barytes = Ponderous earth ; p. 53, Barytic genus combined with the vitriolic acid ; I. von Born, 1790, Baryte vitriolée ; from *βάρυς*, heavy) = Barytes (Engl.), Baryt (Germ.), Barytine (Fr.), Barite (Dana, 1868), Heavy-spar, Schwerspat.

Blende (Old Germ.) = Zinc-blende (Engl.), Zinkblende (Germ.), Blende (Fr.), Blenda (Ital., Span.), Sphalerite. Like the old name Pyrites, this also occurs in several compounds—Hornblende, Pitchblende, Fireblende (= Pyrostilpnite), Manganblende (= Alabandine), Antimony-blende (= Kermesite), &c.—but without giving rise to any confusion.

Bornite (W. Haidinger, 1845) = Erubescite, Phillipsite (Fr.), Buntkupfererz (Germ.).

Chabazite (Bosc d'Antic, 1788, Chabazie, erroneously from *χαλάζιε*) = Chabasite, Chabasie (Fr.).

Chalkopyrite (J. F. Henckel, 1725, Chalcopyrites) = Chalcopyrite, Chalkopyrit (Germ.), Copper-pyrites (Engl.), Kupferkies (Germ.), Kopparkis (Swed.), Cuivre pyriteux (Fr.), Cobre amarillo (Span.), Rame giallo (Ital.).

Chalkosine (F. S. Beudant, 1832, Chalcosine) = Chalkosin (Germ.), Calcosina (Span.), Chalcocite (Dana, 1868), Copper-glance, Kupferglanz.

Chalybite (E. F. Glocker, 1847) = Siderite, Eisenspat. Siderite is in more general use, and the form Siderose as originally applied by F. S. Beudant in 1832 (Sidérose) to ferrous carbonate would perhaps be preferable. The name Siderite has several other meanings. T. Bergman (1790) used it for pharmacosiderite, J. Pinkerton (1811) for hornblende, and C. Moll (1797) for blue quartz. It has been applied to other blue stones, such as lazulite and sapphirine; and Pliny's Adamas Siderites was no doubt sapphire. By the ancients it was also used for loadstone [= magnetite]; and an English quotation showing the use of the word in this sense in 1579 is given in the Oxford Dictionary. Still other uses of this name are in botany for iron-wort, and now very commonly for meteoric irons.

Chessylite (H. J. Brooke and W. H. Miller, 1852) = Azurite, Kupferlasur.

Chrysoberyl = Cymophane (Fr.).

Cinnabar (Latin, Cinnabaris; Gr. κιννάβαρι) = Cinnabarite, Cinabre (Fr.), Zinnober (Germ.).

Cordierite (J. A. H. Lucas, 1813) = Iolite, Dichroite.

Corundum (Hindi, kurund; Sansk. kuruvinda) = Corindon (Fr., Span.), Corindone (Ital.), Korund (Germ.). J. Woodward, 1728, has on different pages the spellings Corivindum, Corivendum, Convindum. C. Greville (1798) and J. L. Bournon (1802) gave the form Corundum.

Euklase (R. J. Haüy, 1792, Euclase) = Euclase, Euklas (Germ.).

Feldspat (J. G. Wallerius, 1747, Felt-Spat, Feltspat) = Felspar, Feldspar, Feldspath (Fr.), Feldspat (Germ.), Fältspat (Swed.), Polevoi shpat (Russ.).

Fluorite (G. Agricola, 1546, Fluores; C. A. Napione, 1797, Fluorite) = Fluor, Fluor-spar, Fluorspar, Fluorine (Fr.), Fluss, Flußspat (Germ.), Flusspat (Swed.), Plavikovyi shpat (Russ.).

Gypsum (Latin, Gypsum) = Gypse (Fr.), Gyps, Gips (Germ.), Gesso (Ital.), Yeso (Span.), Gypsite.

Halite (E. F. Glocker, 1847, Halites) = Salt, Rock-salt, Sal gemme (Fr.), Steinsalz (Germ.), Alite (Ital.).

Hematite (Latin, Hæmatite; Gr. αἱματίτης) = Haematite, Hématite (Fr.), Hämatit (Germ.), Eisenglanz, Ematite (Ital.), Hematita (Span.), Oligisto, Specularite.

Hemimorphite (A. Kenngott, 1853) = Calamine ($H_2Zn_2SiO_5$), Kieselzinkerz.

Hydrohematite (A. Breithaupt, 1847, Hydrohaematit) = Turgite, Turjit, Turite.

Kyanite (A. G. Werner, 1789, Cyanit) = Cyanite, Disthène (Fr.), Disthen (Germ.).

Labradorite (A. G. Werner, 1780, Labradorstein; J. C. Delamétherie, 1797, Labradorite) = Labrador.

Magnesite (J. C. Delamétherie, 1797; first restricted to the carbonate by D. L. G. Karsten, 1808) = Giobertite (Fr.)

Meerschaum (Old Germ.) = Sepiolite, Magnésite (Fr.).

Mispickel (Old Germ.; G. Agricola, 1556, Mistpuckel) = Arsenopyrite, Arsenical pyrites, Arsenkies (Germ.), Mispickel (Fr.), Mispiquel (Span.).

Natrolite (M. H. Klaproth, 1803, Natrolith) = Mésotype (Fr.).

Nepheline (R. J. Haüy, 1800) = Nephelite.

Olivine (A. G. Werner, 1790, Olivin) = Chrysolite, Péridot (Fr.), Olivin (Germ.).

Orthoklase (A. Breithaupt, 1823, Orthoklas) = Orthoclase, Orthose (Fr.), Ortosa (Span.), Orthoklas (Germ.), Kalifeldspat.

Phenakite (N. Nordenskiöld, 1833, Phenakit) = Phenacite, Phénacite (Fr.), Phenakit (Germ.).

Phillipsite (A. Lévy, 1825) = Christianite (Fr.).

Plagioklase (A. Breithaupt, 1847, Plagioklas) = Plagioclase, Plagioklas (Germ.).

Pyrite (Pliny, Pyrites; Gr. πυρίτης) = Pyrites, Iron-pyrites, Eisenkies. (Sideropyrites of J. F. Henckel, 1725, would better compare with Chalkopyrite Argentopyrite, &c. ; compare Blende, above).

Pyrrhotine (A. Breithaupt, 1835, Pyrrhotin) = Pyrrhotite, Magnetkies.

Skapolite (B. J. d'Andrada, 1800, from σκᾶπος) = Scapolite, Skapolith (Germ.), Wernérite (Fr.).

Smithsonite (F. S. Beudant, 1832) = Calamine ($ZnCO_3$), Zinkspat.

Sphene (R. J. Haüy, 1801) = Titanite, Esfena (Span.).

Spinel = Spinelle (Fr.), Spinell (Germ.), Spinella (Ital.), Espinela (Span.).

Spodumene (B. J. d'Andrada, 1800) = Triphane (Fr.), Spodumenite.

Staurolite (J. C. Delamétherie, 1792) = Staurotide (Fr.), Staurolith (Germ.).

Stibnite (J. D. Dana, 1854) = Antimonite, Stibine (Fr.), Antimonit (Germ.).

Stilbite (R. J. Haüy, 1796) = Desmin (Germ.).

Tetrahedrite (W. Haidinger, 1845, Tetraëdrit) = Fahlerz, Panabase (Fr.), Tetraëdrit (Germ.).

Torbernite (A. G. Werner, 1793) = Chalcolite (Fr.), Cuprouranite, Kupferuranit.

In crystallography, although several names have been applied to the crystal-systems these present little difficulty. There is, however, still some confusion in the statement of the hexagonal, rhombohedral, or trigonal systems; and are there six or seven systems of crystals? For descriptive purposes, especially in tabular matter, different methods of briefly stating the system have been tried, but none have found general acceptance. The initial letters of the following are here suggested:

Cubic = kubisch, regular, isometric, monometric, tesseral, octahedral, ter-quaternaire.

Quadratic = tetragonal, pyramidal, dimetric, quaternaire.

Orthorhombic = rhombic, prismatic, trimetric, terbinaire.

Monoclinic = oblique, clinorhombic, monosymmetric, binaire.

Anorthic = triclinic, asymmetric.

Hexagonal including rhombohedral or trigonal = monotrimetric, sénaire, ternaire.

Quadratic (Fr. quadratique), in common use in France, is chosen in preference to tetragonal, since T is also the initial letter of trigonal, triclinic, tesseral, teimetric, ternaire, and terbinaire. R also is avoided, since it stands for rhombic, rhombohedral, and regular. The only difficulty in the scheme suggested above is that O stands also for oblique and octahedral, and M for monometric.

In the nomenclature of the thirty-two classes there is more complexity. Following the historical development of the subject, these classes have been named according to ideas of merohedrism (hemihedrism, tetartohedrism, and hemimorphism), the geometrical shape of the general form, or the degree of symmetry. Some authors refer to the classes by number, e.g. Class 4. The numbering may start with the class of lowest symmetry or with that of highest symmetry, whilst the order between the extremes is arbitrary. A. Schoenflies has devised a system of letters and numbers for the 32 crystal-classes and the 230 space-groups; an objection to which is that it is not easy to print, and modified forms have therefore been given by H. Hilton and R. W. G. Wyckoff.

As an example of the number of terms that have been applied to any one class, the following may be noted:

Dioptase or phenakite class; Rhombohedral class; Rhombohedral tetartohedral; Hexagonal alternating; Trigonal central; Trigonal rhombohedral; Trirhombohedral; Diplohedral trigonal; Rhombohedral with parallel-faced hemihedrism; Hexagonal tetartohedry of the second sort; Rhomboedrische Paramorphie; Ternaire parahémiédrie; Rhomboédrique parahémiédrique; Rhomboédrique hémiédrie hémiaxe centrée; Class XV; Class 15; Class 17; Class 21; Class 31; III Uc; III Mc; C_3^i; $\mathrm{C}_3{}^i$; C_{3i}; C3i; 3Ci; c_3; Γ_3; e; R^2; $\pi\{hkl\}$.

To this total of thirty distinct designations many other slight variations peculiar to different languages might be added, as well as variations in the use of italic or roman type for the symbols. This is a heavy tax on the worker in crystallography, and to the student it is bewildering. One can sympathize with the student who concluded his answer to an examination question with the remark: 'Since different authors give different names to the various classes, the names are here omitted to avoid confusion'.

To a mineralogist the crystal-classes are perhaps most easily visualized by calling to mind some mineral that crystallizes in each class. Since the classes are of secondary importance to the systems, they might be numbered in each system; e.g. C 1 to C 5 for the classes of the cubic system, Q 1 to Q 7 for the quadratic, &c., as listed below. Here the names and order of the classes are those that I adopted for the article 'Crystallography' in the eleventh edition of the 'Encyclopaedia Britannica' (vol. 7, 1910).

	Class (and example).		Class (and example).
C1	Holosymmetric (Fluorite).	Q5	Ditetragonal pyramidal ($\mathrm{AgF.H_2O}$).
C2	Tetrahedral (Tetrahedrite).	Q6	Trapezohedral ($\mathrm{NiSO_4.6H_2O}$).
C3	Pyritohedral (Pyrite).	Q7	Bisphenoidal (?)
C4	Plagihedral (Cuprite).	O1	Holosymmetric (Baryte).
C5	Tetartohedral (Ullmannite).	O2	Pyramidal (Struvite)
Q1	Holosymmetric (Cassiterite).	O3	Bisphenoidal (Epsomite).
Q2	Scalenohedral (Chalkopyrite).	M1	Holosymmetric (Gypsum).
Q3	Bipyramidal (Scheelite).	M2	Hemimorphic (Tartaric acid).
Q4	Pyramidal (Wulfenite).	M3	Clinohedral (Clinohedrite).

(Continued:)

	Class (and example)
A1	Holosymmetric (Axinite).
A2	Asymmetric ($CaS_2O_3 . 6H_2O$).
Hr1	Holosymmetric (Calcite).
Hr2	Ditrigonal pyramidal (Tourmaline).
Hr3	Trapezohedral (Quartz).
Hr4	Rhombohedral (Phenakite).
Hr5	Trigonal pyramidal ($NaIO_3 . 3H_2O$).
Hr6	Trigonal bipyramidal (?)
Hr7	Ditrigonal bipyramidal (Benitoite).
H1	Holosymmetric (Beryl).
H2	Bipyramidal (Apatite).
H3	Dihexagonal pyramidal (Greenockite).
H4	Trapezohedral ($Ba(SbO)_2(C_4H_4O_6)_2 . KNO_3$).
H5	Hexagonal pyramidal (Nepheline).

The positions of crystal-faces and of structure-planes are most logically given by the Millerian indices, which refer to three co-ordinate axes in the order X, Y, Z. This is clearly the only method for international use, and it should take the place of the Lévy notation used by French authors and also the Goldschmidt notation. The latter is excellent for working out crystals on the gnomonic projection, but it obscures, by its simplicity, the three-dimensional reality. In the publication of the final results for the use of other workers this should not be lost sight of. For hexagonal crystals the four-figure Bravais-Miller indices are well known and widely used. Any special devices for writing these with three or fewer indices must be regarded as idiosyncrasies, and they are more usefully kept as working methods in the author's own note-book.

Standardization and agreement are also much needed for the orientation, axes of reference, and the letters assigned to the crystal-forms of each mineral-species. In published papers one often finds a bare statement of the crystal-forms shown by a certain mineral; e. g. a topaz crystal with the forms (110), (021), &c. Such a statement is in itself meaningless; and in a case like topaz, where two sets of parameters are in current use, errors will arise. The orientation of a crystal and the selection of the parameters is in any case more or less arbitrary. An orthorhombic crystal can, for example, be set up in six different ways, and there is a choice of a large number of parameters. Unless the first describer of the crystalline form of a substance is proved to be quite wrong, there is usually very little to be gained by introducing a change in the parameters. The well-known symbol $r(100)$ of Miller and Groth, or $r(10\bar{1}1)$ of Dana and Hintze for the cleavage-form of calcite has been changed without sufficient reason by Goldschmidt to p·1 or $(11\bar{2}1)$; and Miller's $p\,(73\bar{5})$=Dana's $p\,(4 . 8 . \bar{1}\bar{2} . 5)$ he changes to $\mathfrak{F} : -\frac{16}{5}\frac{4}{5}$. This is further complicated by the two Goldschmidt systems 'G_1' and 'G_2', which authors often fail to distinguish, and their results are then unintelligible.

In crystal-optics α, β, and γ are generally used for the three principal indices of refraction. They are sometimes written as $n(\alpha)$, $n(\beta)$, $n(\gamma)$, corresponding with the French n_p, n_m, n_g. The same Greek letters may also conveniently be used to indicate the vibration-directions corresponding to these indices; and so take the place of the German letters $\mathfrak{a}$, $\mathfrak{b}$, $\mathfrak{c}$ or the capitals X, Y, Z (likely to be confused with crystallographic axes) for the 'axes of optical elasticity'.

For general use in descriptive crystallography only few special symbols are really needed. In the fifth volume (not yet issued) of the international 'Tables annuelles de Constantes et Données numériques' I have listed the following:

Explication des symboles cristallographiques et optiques.

$a:b:c$ ou $a:c$, paramètres cristallographiques.

α, β, et γ, angles des axes cristallographiques (dans le système triclinique); α dans le système rhomboédrique; β dans le système monoclinique.

$\chi:\psi:\omega$, paramètres topiques (quotients des distances moléculaires).

n, indice de réfraction dans les corps isotropes (cristaux cubiques et corps amorphes); aussi pour l'indice en général ou approximatif.

ω et ϵ, indices de réfraction (ordinaire et extraordinaire) dans les cristaux uniaxes.

α, β, et γ, indices principaux de réfraction (minimum, moyen, et maximum) dans les cristaux biaxes; aussi les directions de vibration pour ces mêmes indices.

$\omega-\epsilon$, la biréfringence dans les cristaux uniaxes négatifs.

$\epsilon-\omega$, la biréfringence dans les cristaux uniaxes positifs.

$\gamma-\alpha$, la biréfringence maximum dans les cristaux biaxes.

2V, l'angle des axes optiques dans le cristal.

2E, l'angle des axes optiques dans l'air.

2H, l'angle des axes optiques dans un liquide (généralement l'huile).

Bx_a et Bx_o, les bissectrices aiguë et obtuse des axes optiques.

$\mathrm{Bx}_a:c$ ou $\gamma:c$, &c., l'angle d'extinction avec l'axe cristallographique c sur le plan de symétrie (010) d'un cristal monoclinique; + dans l'angle β obtus, − dans l'angle β aigu.

D, densité.

F, point de fusion.

As mentioned above, the international aspect of Science is of prime importance. An original paper is written in the language of one country, but it is more widely read in the sum of other countries.