NOTES AND NEWS

ARE THERE 47 OR 48 SIMPLE FORMS POSSIBLE ON CRYSTALS?

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In a recent paper A. F. Rogers[1] discusses different names of crystal forms now used by crystallographers and gives a list of the names he prefers. He pointed out also that 48 simple crystal-forms are possible.

In my paper on the nomenclature of simple forms adopted by the Fedorov Institute[2] it is shown that there are only 47 of these forms.

While it is quite clear that we can have different opinions of various form-names, concerning the number of possible simple forms there is only a single answer.

It is not difficult to establish that there is a divergence between A. F. Rogers, and our set of forms; here we deal again with a so-called "dome" and "sphenoid," that we consider a single form and call "dihedron."

In order to decide whether we have one or two forms in this case, it is necessary to give a precise definition of the term different "simple forms."

Definition: Two simple forms are different if they have a different number of faces, or if they differ in the shape, or mutual position of their faces.

If two forms have the same above mentioned properties they are not different, they belong to the same sort of polyhedrons, in spite of a difference in the symmetry operations by which they are obtained.

We follow this definition, and A. F. Rogers does also. He proves very clearly for instance (p. 839) that the $h\ k\ 0$ form of the rhombic syngony and the $h\ k\ l$ form of the monoclinic syngony are both rhombic prisms, and that the form consisting of two parallel faces in all symmetry classes must be called pinakoid.

In his list of simple forms (p. 842) he does not distinguish between the octahedron, derived in the polygyric central ($3G_2 \cdot 4G_3 \cdot 3P$ C) class by means of P or C, and the octahedron derived in the polygyric axial ($3G_1 \cdot 4G_3 \cdot 6a_2$) class, by means of symmetry axes.

Also the forms {100} both in the tetragyric primitive G_4 class and in tetragyroidic primitive G_{4i} class, are named by Rogers tetragonal prisms although they are obtained by means of quite different symmetry operations.

Dipyramids, both in central (dipyramidal) and in axial (trapezohedral) classes of various syngonies, are also three exellent examples of this kind.

[1] Rogers, A. F., A tabulation of crystal forms and discussion of form-names: *Am. Mineral.*, vol. **20**, pp. 838–851, 1935.

[2] Boldyrev, A. K., Die von Fedorov-Institut angenommene kristallographische Nomenklatur: *Zeit. Krist.*, vol. **62**, pp. 145–150, 1925.

Only the use of both "dome" and "sphenoid" appears as an incomprehensible exception.

Fedorov pointed this out about 50 years ago and has replaced these two names by "hemiprism," which we have changed, according to G. V. Vulp, to "dihedron." We cannot use either one of the two former terms "dome," or "sphenoid," if we wish to avoid confusion, considering the old restricted sense of these words. Besides, it is well to remember that δῶμα means *plane (not ridged) roof* like our monohedron (not dihedron).

To use these two names (as many crystallographers do) and to count 48 simple forms instead of 47 is not an opinion but a mistake, like the assertion that there are not 32 but 33 classes of crystal symmetry.

In addition to the above I will note that we agree entirely with A. F. Rogers' severe criticism of form-names that are based (1) on the position of the constituent faces with respect to the crystallographic axes, (2) on the mineral names, (3) on the merohedrism. Of course A. F. Rogers is quite right in declaring that only one method of form-naming, according to the number and shape of the faces, is adequate.

In relation to the list of simple form-names proposed by A. F. Rogers I can note that 32 of these names are identical with the names accepted by the Fedorov Institute, but 15 are different. Among the latter 5 belong to the lower and middle syngonies, and 10 others to the polygyric (cubic) syngony.

In the follow table I will give all 47 terms of the Fedorov Institute and 15 distinct names proposed by A. F. Rogers.

Names Accepted by the Fedorov Institute		Names Proposed by A. F. Rogers
1. Monohedron	=	Pedion
2. Dihedron	=	Sphenoid and Dome
3. Pinakoid	=	Pinakoid
4. Rhombic Prism	=	Rhombic Prism
5. Rhombic Pyramid	=	Rhombic Pyramid
6. Rhombic Tetrahedron	=	Rhombic Disphenoid
7. Rhombic Dipyramid	=	Rhombic Dipyramid
8. Tetragonal Tetrahedron	=	Tetragonal Disphenoid
9. Tetragonal Pyramid	=	Tetragonal Pyramid
10. Tetragonal Prism	=	Tetragonal Prism
11. Tetragonal Scalenohedron	=	Tetragonal Scalenohedron
12. Tetragonal Trapezohedron	=	Tetragonal Trapezohedron
13. Tetragonal Dipyramid	=	Tetragonal Dipyramid
14. Ditetragonal Pyramid	=	Ditetragonal Pyramid
15. Ditetragonal Prism	=	Ditetragonal Prism
16. Ditetragonal Dipyramid	=	Ditetragonal Dipyramid

Names Accepted by the Fedorov Institute		Names Proposed by A. F. Rogers
17. Trigonal Pyramid	=	Trigonal Pyramid
18. Trigonal Prism	=	Trigonal Prism
19. Trigonal Dipyramid	=	Trigonal Dipyramid*
20. Trigonal Trapezohedron	=	Trigonal Trapezohedron
21. Rhombohedron	=	Rhombohedron
22. Ditrigonal Scalenohedron	=	Hexagonal Scalenohedron
23. Ditrigonal Prism	=	Ditrigonal Prism
24. Ditrigonal Pyramid	=	Ditrigonal Pyramid
25. Ditrigonal Dipyramid	=	Ditrigonal Dipyramid
26. Hexagonal Pyramid	=	Hexagonal Pyramid
27. Hexagonal Prism	=	Hexagonal Prism
28. Hexagonal Trapezohedron	=	Hexagonal Trapezohedron
29. Hexagonal Dipyramid	=	Hexagonal Dipyramid
30. Dihexagonal Pyramid	=	Dihexagonal Pyramid
31. Dihexagonal Prism	=	Dihexagonal Prism
32. Dihexagonal Dipyramid	=	Dihexagonal Dipyramid
33. *Tetrahedron*	=	Tetrahedron
34. Trigon-tritetrahedron	=	Tristetrahedron
35. Tetragon-tritetrahedron	=	Deltohedron
36. Pentagon-tritetrahedron	=	Tetartoid
37. Hexatetrahedron	=	Hexatetrahedron
38. *Octahedron*	=	Octahedron
39. Trigon-trioctahedron	=	Trisoctahedron
40. Tetragon-trioctahedron	=	Trapezohedron
41. Pentagon-trioctahedron	=	Gyroid
42. Hexoctahedron	=	Hexoctahedron
43. *Hexahedron* (cube)	=	Cube
44. Tetrahexahedron	=	Tetrahexahedron
45. Rhombo *dodecahedron*	=	Dohecahedron
46. Pentagondodecahedron	=	Pyritohedron
47. Didodecahedron	=	Diploid

* Belongs to hexagyric (or hexagonal) syngony.

Concerning the 15 different names we must remark as follows:

1. Pedion is a new Greek word in the nomenclature. We can and must avoid it. The term "monohedron" agrees very well with other terms of the whole nomenclature.

2. The same can be said about "dihedron."

3. 4. As we do not accept the name "sphenoid" we must refuse "disphenoid" also, as a new Greek word.

5. Ditrigonal scalenohedron is better than hexagonal scalenohedron because this form belongs to the trigonal, not to the hexagonal, syngony.

As to the forms of polygyric syngony we will make the following remarks:

(a) Many terms used by A. F. Rogers do not agree with the accepted principal: to name the forms according to the number and shape of the faces. Such are: tetartoid, gyroid, (cube), pyritohedron, diploid.

(b) The current form-names in cubic syngony are based on very diverse principles. Therefore we are obliged to use here new names in spite of the inconvenience of such a method.

(c) Our terms are selected according to a strict plan. As is shown in the previous table, 15 simple forms of the polygyric syngony may be classified into four "families": related to the tetrahedron, octahedron, hexahedron and the dodecahedron. All our form-names of each "family" are built up uniformly.

Our experience in teaching has shown that this nomenclature is very easily grasped by students: after hearing the names of the forms belonging to the tetrahedral "family" they derive themselves all other names, almost without help from the teacher.

(d) One defect of our terms is that they are longer than many others. But this defect redeems itself by their positive qualities mentioned above.

The only adequate method of *naming the symmetry classes* is the naming according to the symmetry elements and not according to any one form. For details see our paper on this subject.[3]

[3] А. К. Боллырев и В. В. Доливо-Добровольский. Классификация, номенкдатура и симводика 32 видов симметрии кристал дов) (Classification, nomenclature and symbolization of 32 symmetry classes of crystals. (Russian with German "Zusammenfassung"). (Залиски Ленинг радского Горного Института УШ. **1934.** 145–159.