THE CHEMICAL FORMULA OF THE 'ZIRCON PYROXENES' AND THE 'ZIRCON PECTOLITE'

BY

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The zirconiumbearing minerals: Låvenite, Wöhlerite, Hiortdahlite and Rosenbuschite were found for the first time in the nephelite-syenitic pegmatite veins of the Langesund fjord in Southern Norway. W. C. BRØGGER has studied these four minerals very accurately[1]. As a result of his examination BRØGGER concluded that these zirconiumminerals were closely related both crystallographically and chemically to the Pyroxenes and to Pectolite. He therefore proposed the name Zircon-pyroxenes for Låvenite, Wöhlerite, Hiortdahlite and Zircon-pectolite for Rosenbuschite. The following tables show the relations:

Mineral	a : b : c	α	β	γ
Diopside	1,092 : 1 : 0,587	-	74° 13′	-
Aegirite	1,098 : 1 : 0,601	-	73° 9′	-
Låvenite	1,096 : 1 : 0,715	-	69° 43′	-
Wöhlerite	1,054 : 1 : 0,709	-	71° 3′	-
Hiortdahlite	1,058 : 1 : 0,705	90° 29′	71° 11′	90° 8′
Pectolite	1,072 : 1 : 0,937	-	84° 37′	-
Rosenbuschite	1,169 : 1 : 0,978	-	78° 13′	-

Låvenite:

$6\,[(Mn, Fe)\,(Ca, Na_2)\,Si_2O_6] \cdot 2\tfrac{1}{2}\,[ZrSi_2O_6] \cdot 2\,[(Na_2)_2Zr_2F_4O_4] \cdot 1\tfrac{1}{2}\,[(Na_2, H_2)_2\,(Zr, Ti)_2O_6]$

Wöhlerite:

$6\,[(Ca, Na_2)\,Si_2O_6] \cdot [(Na_2, H_2)_2Zr_2F_4O_4] \cdot [Ca(Mg, Fe, Mn)\,(Zr, Ti, Si)_2O_6] \cdot \tfrac{2}{3}\,[CaNb_2O_6]$

Hiortdahlite:

$6\,[Ca_2Si_2O_6] \cdot 2\,[(Na_2, Ca, H_2)_2Zr_2F_4O_4] \cdot \tfrac{2}{3}\,[Ca(Mg, Fe, Mn)\,(Zr, Ti, Si)_2O_6]$

Rosenbuschite:

$6\,[CaSiO_3] \cdot 2\,[Na_2ZrO_2F_2] \cdot [Ti(SiO_3)\,(TiO_3)]$

[1] Zeitschr. f. Krist. *16*, 1890.

Chemical Analyses of the Zircon Pyroxenes.

	Låvenite	Wöhlerite	Hiortdahlite	Rosenbuschite
Ceritoxides	-	0,66	-	0,33
CaO	6,93	26,95	32,53	24,87
Na_2O	11,23	7,50	6,53	9,93
MnO	7,30	1,00	0,96	1,39
FeO	3,02	1,26	0,94	-
MgO	-	0,12	0,10	-
ZrO_2	28,90	16,11	21,48	20,10
$(Nb, Ta)_2O_5$	4,13	Nb_2O_5 12,85	-	-
Fe_2O_3	0,78	0,48	0,34	1,00
TiO_2	2,00	0,42	1,50	6,85
SiO_2	29,17	30,12	31,60	31,36
H_2O	0,65	0,74	0,58	-
F	3,82	2,98	5,83	5,83
Insoluble Zircon	3,08	-	-	-
	101,01	101,19	102,39	101,66
O eq. 2F	÷ 1,60	÷ 1,24	÷ 2,43	÷ 2,45
	99,41	99,95	99,96	99,21

	Låvenite		Wöhlerite		Hiortdahlite		Rosenbuschite	
Cer Metals	-		4		-		-	
Ca	124		482		579		449	
Na	363		242		211		324	
Mn	103		14		14		2	
Fe''	42	935 : 3,87	18	998 : 4,01	13	1019 : 3,85	-	1061 : 4,05
Mg	-		3		3		-	
Zr	237		132		176		159	
Nb Ta	31		92		-		-	
Fe'''	10		6		4		13	
Ti	25		5		19		93	
Si	487	487 : 2,01	503	503 : 2,02	533	533 : 2,03	524	524 : 2,00
OH	72		82		64		-	
F	200	2176 : 9,00	156	2242 : 9,00	305	2360 : 9,00	307	2358 : 9,00
O	1904		2004		1991		2051	

General formula: $R_4Si_2X_9$ where R = Ca, Na, Mn, Fe, Mg, Zr, Nb, Ta, Ti
X = O, OH, F

Analysts: Låvenite, Wöhlerite, Hiortdahlite, Rosenbuschite } P. T. CLEVE by W. C. BRØGGER, Zs. f. Krist. *16*. 1890.

To the mineralogists of those days the above formulae seemed to explain excellently the crystallographic agreement with Pyroxene and Pectolite. BRØGGERS interpretation does not, however, match our present knowledge of isomorphous substitution. We know f. ex. that Na cannot be replaced by H, neither Si by Ti, Zr or Nb, nor any ion by two ions with half the valence.

In the following I will try to interprete the chemical analyses according to modern views of the isomorphous substitution.

We observe in the first place that the analyses contain no ions which are able to replace silicon. We know further that OH and F substitutes each other very easily and that these monovalent ions may replace oxygen to a certain extent. This knowledge is sufficient to enable us to deduce the chemical formula in a form $R_mSi_nX_p$, where R represents all cations save silicon, and X the anions. This is done in the tables, and we get as result the same general formula for all four minerals, namely:

$$R_4Si_2X_9.$$

We can write the formula better as:

$$R_4Si_2O_7(O, OH, F)_2$$

It is, of course, possible that not all cations R replace each other in the lattice, i. e. that they fall into two different groups, between which isomorphous substitution does not take place. Without a complete determination of the crystal structure we cannot give a definite answer to this question, but it is my opinion that we can consider all cations R as forming principally one constituent of the molecule.

From the above formula we see at once that no chemical relations to Pyroxenes or Pectolite exist. The names Zircon-pyroxene and Zircon-pectolite have therefore no justification at all. A close similarity in the crystal lattice cannot be expected, but it is just conceiveable that the crystallographic relations to Pyroxene and Pectolite are due to the fact that certain features (f. ex. in the arrangement of the oxygens) in the structure may be common.

It would be a very interesting task to study the relations between these 4 zirconiumbearing minerals themselves, and I hope in a later paper to be able to give some information about this problem.

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