CESIUM KUPLETSKITE, A NEW MINERAL[1]

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In 1965 Stavrov and Portnov published an article [1] which drew the attention of investigators for the first time to the high cesium content (1.32 percent) of astrophyllite from pegmatite of the Burpala pluton. However, during field work here in the summer of 1964, Ganzeyev and Yefimov detected astrophyllite with a still higher cesium content of 2.5 percent in a new (for this pluton) genetic type of mineralized zone.

Therefore, we decided to reanalyze astrophyllite from various bodies of alkalic granite, alkalic syenite and nepheline syenite for lithium, rubidium and cesium. The general results of our work have already been published [2], but we would like to describe here the new mineral detected during our investigation.

Our astrophyllite specimens included three specimens collected by Dusmatov from alkalic metasomatite in one of the Alay alkalic plutons. All these specimens had high cesium content (1.2, 3.26 and 10.8 percent). One was so rich in Cs_2O (11.6 percent) that cesium was the main cation in group A (alkali-metal group), even when expressed in terms of atomic content. Consequently, this new mineral of the astrophyllite group can be classified as a cesium mineral and called cesium kupletskite because the predominant cation in group B is manganese.

The mineral was detected in veins of metasomatized aegirine-quartz-microcline pegmatite cutting fine-grained leucocratic biotite and, less commonly, tourmaline granite, as well as alkalic quartz syenite. The rare-metal mineralization in such veins is confined mainly to the substituting albite or polylithionite-quartz complex. This complex also contains segregations of cesium kupletskite, which generally are in paragenesis with pyrochlore, stillwellite, tienshanite, sogdianite, thorite and other accessory rare-metal minerals. Some of these minerals have already been described in our previous publications.

Cesium kupletskite is distributed in the studied specimens as rosette-shaped intergrowths of bent flaky crystals, or as discrete packets of bent scales, and locally forms accumulations as much as 2 x 3 cm in diameter (Table 1). It is confined mostly to the boundary between unreplaced aegirine-quartz-microcline pegmatite and irregular segregations of the substituting complex, composed of saccharoidal quartz and polylithionite.

The mineral is golden brown and has a fairly dull luster, which resembles the luster of vermiculite rather than the strong luster typical of astrophyllite from most alkalic plutons. The specific gravity is 3.68. The microhardness is 186 kg/mm², or about 4 on the Mohs scale. Optically, the mineral is biaxial and positive. Its pleochroism is brown along γ, yellowish brown along β and yellowish green along α; $\gamma = 1.758$, $\beta = 1.726$, $\gamma = a$, $b\beta = 10°$[2], $2V = 75°$. The X-ray powder pattern of the mineral (Table 2) is identical to the standard X-ray powder pattern of astrophyllite and, contrary to expectation, does not show any significantly larger interplanar spacings. The unit-cell parameters of cesium kupletskite, determined by the oscillation method with an RKOP camera (Table 1), are also only slightly larger than those of normal astrophyllite.

The sum of the constituents (Table 3), despite every possible precaution and the replicate determination of individual constituents, is too low not only because of the very great difficulties involved in any chemical separation of the complete range of alkali elements, but also because of the comparatively low accuracy of the determination of cesium by flame photometry at such high concentrations. However, we should note that the high Cs_2O content of the mineral (more than 10 percent) is confirmed both by three replicate chemical determinations (averaging 10 percent) and by ten replicate determinations with the flame photometer (averaging 11.6 percent). Parallel determinations of all constituents but alkalies show ideal convergence.

Recalculation of the analysis to the crystallochemical formula of astrophyllite[3] gives fairly

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[1] Translated from: Tseziykupletskit-novyy mineral. Doklady Akademii Nauk SSSR, 1971, Vol. 197, No. 6, pp. 1394-1397.

[2] The exact value of $b\beta$ could not be determined because of the absence of well-defined crystals and the very inexplicit cleavage parallel to 010. The refractive index ϵ could not be determined because of the fine scaly nature of the mineral.

[3] Our recalculation was based on the quotient obtained by dividing the sum of atomic proportions of cations by 20 atoms of cations in the crystallochemical formula of the mineral [8]. The accuracy of the mineral formula is also confirmed by our recalculation of the analysis by Hey's method and by our calculation of the specific gravity (which is 3.62).

Table 1

	Cesium Kupletskite, Alay Range	Astrophyllite, Khibiny [7]	Kupletskite, Lovozero [7]	Niobophyllite, Sill Lake,Canada [8]
Mode of occurrence	Rosette-shaped intergrowths of bent scales and discrete scales	Aggregates of flaky and acicular crystals	Flaky segregations or discrete scales	Minute scales uniformly disseminated through the rock
Color	Golden brown	Golden brown to bronze yellow	Dark brown to black	Brown
Luster	Faintly vitreous	Highly vitreous	Highly vitreous	Vitreous
Cleavage	Perfect Along 001	Perfect Along 001	Perfect Along 001	Perfect Along 001
Specific gravity	3.68	3.30	3.20	3.42
γ	1.758	1.738	1.731	1.772
β	1.726	1.705	1.699	1.760
$b\beta$, deg	~10	—	12°30′	—
$2V$, deg	75	70	79	60
a_0. Å	5.41±0.01	5.36 *		5.391
b_0. Å	11.74±0.02	11.76 *		11.88
c_0 Å	21.16±0.04	21.08 *		21.16
α. deg	89	89		
β. deg	90	90		
γ. deg	102°23′	102°30′		

*Astrophyllite, El Paso (Colorado) [6].

good convergence with the standard formula:

$$(Cs_{1.22}K_{0.35}Na_{1.14}Ca_{0.09})_{2.80}(Mn_{3.99}Fe_{2.00}Fe_{0.55}Li_{0.44})_{6.98}(Ti_{1.49}Nb_{0.54}Zr_{0.12})_{2.15}\times$$
$$\times(Si_{7.92}Al_{0.15})_{8.07}O_{24}(O_{3.69}OH_{2.35}F_{0.96}).$$

In addition to the high cesium content, other chemical characteristics of the mineral include: 1) the dominance of manganese over iron, 2) the very low ferrous iron content, 3) the high niobium content, and 4) the relatively high zirconium and lithium contents.

On the basis of the above chemical characteristics of the mineral we can draw the following, partly hypothetical conclusions: a) in minerals of the astrophyllite group there appears to be unlimited isomorphism between potassium and cesium; b) the high niobium content of the mineral again emphasizes the extensive isomorphous substitution of niobium for titanium, which continues until niobophyllite is formed [6]; c) isomorphism between titanium and zirconium is evidently fairly widespread in the mineral.

Only two cesium minerals - pollucite, $CsAlSi_2O_6\cdot nH_2O$, and avogadrite, $(K, Cs)B_4F$ - are known at present. In pollucite cesium occupies a specific structural position. However, in avogadrite cesium isomorphously replaces potassium, so it is not strictly a proper cesium mineral because in terms of atomic content cesium does not account for more than 10 percent of the potassium present in the mineral.

In our new cesium mineral(cesium kupletskite) cesium is the atomically dominant cation in group A, so apart from pollucite it is the only other proper cesium mineral that has so far been discovered.

The principal reason why cesium appears in nature mainly in dispersed state appears to be its chemical similarity to potassium (one of the main rock-forming elements), rather than its low clarke, because beryllium, which has the same clarke, forms more than 40 proper minerals. This is confirmed by the persistently high cesium content of potassium minerals like microcline (compared with albite), kalsilite (compared with nepheline) and mica (compared with pyroxene).

Nevertheless, the existence of cesium beryl shows that cesium can be incorporated into minerals which do not contain potassium but have large structure vacancies. This possibility has been somewhat exaggerated by Stavrov and Portnov [1]; they even completely refute the critical role of isomorphism in the dispersion of cesium in nature. However, in most cases the type of distribution of cesium in minerals does not support their assumption. Thus in potassium-free minerals like catapleiite, eudialyte and leucosphenite, whose lattices are built up of ring structures and are in direct paragenesis with cesium astrophyllite [2], the cesium content is several orders lower.

The existence of specific crystallochemical conditions appears to be necessary for the replacement of potassium by cesium, which is a considerably larger atom. Therefore, in the general case of cesium enrichment of minerals, the cesium concentration should be maximum in potassium minerals, where potassium atoms occupy the largest space. This also happens

Table 2

X-Ray Powder Patterns of Astrophyllites of Different Composition

Cesium kupletskite (λ-Cu)		Niobophyllite [6] (λ-Cu, Co filter)		Astrophyllite ASTM No. 14 194 (λ-Fe)		Kupletskite [7]	
I	d, Å	I	d, Å	I	d, Å	I	d, Å
10	10,4	9	10.52	10	10.6		
		3	9.68	3	9.82		
		1/2	6.15				
		2	5.76	1	5.79		
		1	5.26				
		1/2	5.15				
		1	4.696				
		3	4.42				
1	4,35			1	4.34		
			4.303				
		1/2	4.20				
3	4,09	3	4.059	1	4.07		
		1/2	3.87				
3	3.76	4	3.741	2	3.73		
8	3.54	10	3.500	8	3.51	8	3.505
		1/2	3.40				
3	3,27	5	3.258	2	3.25	1	3.249
		1w/2	3.12				
2	3,09	1	3.071	2	3.07		
3	3,01	6	3.019	2	3.01	1	2.998
1	2,93	1	2.977	1	2.96		

Cesium Kupletskite (λ-Cu)		Niobophyllite [6] (λ-Cu, Co filter)		Astrophyllite ASTM No. 14 194 (λ-Fe)		Kupletskite [7]	
I	d, Å	I	d, Å	I	d, Å	I	d, Å
2	2.88	3	2.859	2	2.86		
		1/2	2.82				
8	2,79	8	2.77	6	2,77	1	2.764
		1/2	2.72				
8	2,66	1	2.662				
		3	2.636	6	2.64	8	2.642
6	2.58	7	2.574	6	2.57	4	2,573
2	2.48	4	2.475	2	2,47		
2	2.36			1	2,38		
3	2,30			2	2,29	1	2.294
2	2.24			1	2.22	1	2.212
3	2,13			2	2.11	3	2,099
2	2.06			1	2.04		
4	1.772			3	1,757		
2	1.743			2	1,729	3	1.732
2	1.661			2	1.651	1	1.665
				1	1.594	1	1,590
3	1.579			2	1.576		
2	1.563			1	1.552	1	1,553
1	1.447			1	1.435	1	1.438
1	1.410			1	1.407	1	1.408
				1	1.314		

Table 3

Chemical Composition of Astrophyllites (in Weight Percent)*

Constituent	Cesium kupletskite, Alay Range	Astrophyllite, Khibiny [7]	Kupletskite, Lovozero [7]	Niobophyllite [6]
SiO_2	33.00 (5494)	34.78	32.60	33.40
TiO_2	8.28 (1036)	11.86	12.04	2.94
Nb_2O_5	4.95 (372)		0.66	14.76
ZrO_2	1.01 (82)	0.57	1.19	1.50
Ta_2O_5	0.06 (3)			0.52
Al_2O_3	0.52 (102)	0.60	1.68	0.89
Fe_2O_3	3.05 (382)	2.76	5.44	23.74
FeO	10.00 (1391)	26.71		—
MnO	19.66 (2771)	6.65	27.65	9.83
CaO	0.35 (62)	1.61	3.60	0.72
SrO	—	0.05	—	—
BaO	—	0.15	—	—
MgO		1.54	2.98	0.16
Na_2O	2.46 (794)	3.00	2.14	2.49
K_2O	1.15 (244)	5.90	4.38	5.51
Li_2O	0.46 (307)	—		—
Rb_2O	0.18 (19)	—		—
Cs_2O	11.60 (823)	—		—
F	1.26 (663)	0.86	1.22	0,46
Cl	—	0.35		
H_2O^+	1.47 (1634)	2.98	3.83	3.64
H_2O^-		0.11	1.08	0.08
	99.46	100.48	100.49	100.64
$-O=F_2$	0.54	0.44	0.51	0.19
	98.92	100.04	99.98	100.45
Analyst	Z.T. Katayeva	N. Vlodavets	T.A. Burova	See Nickel et al., [6]

*Atomic proportions are given in parenthesis.

in astrophyllite, where potassium (unlike sodium) is surrounded at the top and the bottom by six-member cyclic oxygen groups [8]. This is the reason why the lattice dimensions of astrophyllite are not greatly increased by the substitution of cesium for potassium.

Finally, we hope that our find of a new cesium mineral, so far in very small quantities, will draw the attention of geologists to the possible occurrence of cesium astrophyllite in economic concentrations. Our specimens of cesium kupletskite have been sent to the Mineralogical Museum, USSR Academy of Sciences, in Moscow.

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EUCRYPTITE IN PETALITE-MICROCLINE PEGMATITE OF SOVIET CENTRAL ASIA[1]

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Eucryptite has been observed in petalite-microcline pegmatite that forms veins 5 to 30 m wide and as much as 200 m long and lies in massive dark-gray quartzose sandstone. The veins exhibit sharp contacts with the sandstone. All of this pegmatite (apart from a thin contact rim), consist of giant-block pegmatite which has 40 to 70 percent microcline, 30 to 50 percent fine-grained clumps of petalite, and 10 to 15 percent of coarse-grained quartz. Also present are albite, andalusite, and pseudomorphs of muscovite after andalusite. The microcline forms blocks, some of which are 0.8 x 1.5 x 2.5 m in size. The petalite is present only as fine-grained, extremely dense and viscous grayish-white aggregates, which are xenomorphic and which occupy gaps between blocks of microcline. These petalite aggregates range in size from 0.5 x 0.5 to 1 x 3 m, and characteristically contain minute sinuously curved skeletal spodumene crystals. We have previously described [3] the structure of these aggregates and the composition and properties of the petalite.

Eucryptite was observed during microscopic examination of the above aggregates. It was not identified macroscopically and in no way differs from the surrounding small grayish-white grains of quartz and petalite. Petalite aggregates containing eucryptite also differ in no way from other parts of the pegmatite bodies.

The eucryptite occurs as aggregates of grains 0.01 to 1 mm in size, which occur among grains of quartz and petalite of the same size, judging from thin sections. The aggregates are roughly tabular and elongated, with a maximum length of 10 to 15 mm and widths of 2.5 to 3 mm. These clumps (Fig. 1) contain 60 - 80 percent of the eucryptite grains (1), the balance being quartz (2).

The eucryptite forms sharply defined rectangular grains. Crystal sections nearly perpendicular to the optic axis are hexagonal. The arrangement of individual tablets of eucryptite in the aggregate closely resembles a checkerboard pattern. The gaps between the eucryptite grains are filled by quartz grains of equal size, or in places by albite (1 to 3 on the Ab-An scale). Some of the eucryptite aggregates have fairly sharp boundaries, while in others the eucryptite grains become smaller towards the boundary, and the aggregate grades into the surrounding quartz. Some clumps of eucryptite are surrounded by 0.1 to 0.2 mm wide rims of fine-grained quartz. If the quartz within an aggregate is replaced by albite, the rim also consists of albite. Sporadically, there are isolated grains or groups of grains of eucryptite among quartz and petalite; in such cases the eucryptite and petalite exist in complicated intergrowths having odd dendritic outlines of the grains. One cannot deduce the sequence of deposition of eucryptite and petalite from such intergrowths; the minerals appear to have been produced simultaneously. The

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[1] Translated from: O nakhodke evkryptita v petalit-mikroklinovykh pegmatitakh Sredney Azii. Doklady Akademii Nauk SSSR, 1971, Vol. 197, No. 6, pp. 1398-1401.