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Composition and structural state of K-feldspars from some U.S. pegmatites

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Abstract

Concentrations of Ba, Sr, Rb, and Cs, X-ray monoclinic and triclinic ordering, and Ab content in 66 samples of K-feldspars (Kfs) from different pegmatites of the Appalachians and Rocky Mountains have been determined. Maximal contents of Ba and Sr and minimal Rb and Cs are found in the earliest generations of Kfs in muscovite pegmatites. The Kfs of raremetal pegmatites contain maximal Rb and Cs but minimal Ba and Sr. As a rule, the Kfs of raremetal–muscovite and non-specialized pegmatites have intermediate geochemical characteristics.

In all pegmatites Rb (and Cs) contents increase and Ba (and Sr) contents decrease from earliest to latest generations of Kfs. The Ba:Rb ratio is a sensitive indicator of pegmatite specialization (using early Kfs) or recrystallization (using comparison of Kfs generations). It is suggested that high pressure can enhance the isomorphism of Ba and Sr in Kfs and inhibit that of Rb and Cs.

Maximum microclines are predominant among Kfs of U. S. pegmatites. Orthoclase or high and intermediate microcline structures are characteristic of Kfs containing large quantities of Ab, Ba, and Rb, if the pegmatites have not been altered.

Introduction

The potash feldspars (Kfs) are major components of granites and granite pegmatites. The study of their structural state and composition has always been one of the most interesting directions in petrology and mineralogy. It is enough to recall the generalizing works by Barth (1969), Laves (1952), and Marfunin (1962), where Kfs composition and structure were correlated with the formation conditions, and the effect of ordering factors on crystal structure was demonstrated.

With the appearance of new analytical techniques and rapid methods of X-ray crystallographic study, the significance of Kfs as typomorphic minerals of granites and pegmatites has increased. The diagnostic importance of trace-elements (Solodov, 1962; Shmakin and Kostyukova, 1969; Gordienko, 1976), and the good possibilities for quick and accurate determination of Kfs structural state by powder diffractometry (Shmakin and Afonina, 1967; Afonina *et al.*, 1976; Sosedko, 1976) have been shown many times.

The mineralogy and internal structure of U. S. pegmatites were investigated in the 1940s and 1950s. However, the composition and structural state of Kfs were not extensively studied. There are geochemical observations for some pegmatite veins only (Bray, 1942; Shimer, 1943; Carl, 1962). It thus seemed promising to study the composition and structure of Kfs for American pegmatites in order to compare them with the pegmatite Kfs of Siberia and other regions previously studied. The possibility of such an investigation was realized at the time of the author's scientific mission to the U.S. (April and May of 1975).

Deposits of muscovite, rare metals, and ceramic raw materials in pegmatites, and many pegmatite veins without clear industrial utilization, were visited. They occur in the two largest pegmatite regions of the U.S., the Appalachians (from Georgia to Connecticut) and the Rocky Mountains (Colorado, Wyoming, and South Dakota). The Appalachian pegmatites are confined to Paleozoic metamorphic and intrusive rocks. Their absolute age determined by different methods is between 250 and 420 $\times 10^6$ years (Brookins *et al.*, 1969). The pegmatites of the Rocky Mountains (including the Black Hills area) are confined to Precambrian rocks: granites, gneisses, am-

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phibolites, and crystalline schists of varied composition. The absolute age of these rocks is from 850 to 1400×10^6 years, and the larger figure is thought to be more correct (Jack A. Redden, personal communication).

Methods

The sampling of pegmatites and preliminary diagnosis of minerals was done by the author at quarries, mines, roadcuts, and natural exposures. In the case of zonation in the pegmatite body, separate Kfs samples were taken from the endocontact zone, from graphic, apographic, and hypidiomorphic texture zones, and from idiomorphic crystals in druses and block structure. Sometimes the granites from the exocontact zone were sampled as well.

The preparation of monomineralic Kfs separates, and the analyses, were carried out in laboratories of the A. P. Vinogradov Institute of Geochemistry, Siberian Branch of the USSR Academy of Sciences.

Primary samples had a weight of 50–200 grams. They were parts of large Kfs crystals or intergrowths of Kfs and quartz and/or plagioclase. The representativity of sampling big pegmatite crystals by small portions was proved by our special study (Ogneva *et al.*, 1971). The uniform distribution of minor elements in Kfs crystals of one pegmatite zone has been shown by many authors.

The weight of the final monomineralic Kfs samples was 2 g ± 100 mg. Their freshness was checked with a microscope and by color reactions. The albite content in the pure material was determined by an X-ray method with an accuracy of ±10 percent. As a rule we had 85–95 percent Kfs content in the samples.

The samples were powdered in a jasper mortar to pass 200 mesh and were divided into three parts: for X-ray crystallography, emission spectrography, and flame photometry. Using a new X-ray method (Afonina *et al.*, 1976), monoclinic ordering Δ_Z and triclinicity Δ_p, approximately corresponding to Thompson's (1969) coefficients Z and Y, were measured. The accuracy of this method is ±0.05.

Ba and Sr contents were determined by emission spectrography, and Rb and Cs by flame photometry. The measurement error of both methods is characterized by a variation coefficient of 5–15 percent, depending on the element concentration. The correctness of results was guaranteed by using state standards.

Results

Tables 1–4 present the minor-element contents and structural states of 66 Kfs samples. The first two tables include data on Appalachian pegmatites, separately for Georgia and Connecticut (Table 1) and North Carolina (Table 2).

Table 1 shows that Kfs from muscovite pegmatites (Newton Prospect mine) are sharply enriched in Ba and Sr, whereas Rb and Cs contents are relatively low. In contrast, the Kfs of the Tollgate pegmatite (Connecticut), which is of the raremetal–muscovite type, contain the lowest quantity of Ba (and Sr), and elevated Rb concentrations. As a result of such differ-

Table 1. Contents of trace elements (ppm) in K-feldspars of some Appalachian pegmatites, their monoclinic (Δ_Z) and triclinic (Δ_p) ordering, and albite content (Ab, weight percent)

Pegmatite field, state	Specialization of pegmatites	Place of sampling	Texture (zone)	Spec.	Ba	Sr	Rb	Cs	Ba:Rb	Δ_Z	Δ_p	%Ab
Gladesville, Georgia	Muscovite	Newton Prospect Mine	Graphic	13	6400	540	364	5	17.6	0.92	0.89	5
			Fi.-gr.	15	5800	540	296	7	19.6	0.93	0.92	5
	Raremetal-muscovite	Feldspar Company quarries	Graphic	3	1100	330	372	6	2.96	0.94	0.89	3
			Block	7	85	68	456	9	0.19	1.0	0.89	10
			Sm.-bl.	18	510	180	552	52	0.92	1.0	0.96	3
Middletown, Connecticut	Absent	Hale quarry	Graphic	376	65	50	787	57	0.083	1.0	0.94	5
			Sm.-bl.	378	76	63	742	55	0.103	0.94	0.96	10
		Roadcut	Graphic	388	110	70	610	13	0.180	0.93	0.94	10
	Raremetal-muscovite	Tollgate Mine	Block	380	27	18	1425	28	0.019	0.92	0.96	15
			Block	383	40	16	1085	11	0.037	0.95	0.91	10
	Raremetal	Strickland quarry	Graphic		100	55	710	75	0.141	0.94	0.94	35

Abbreviations as follows: Apogr. - apographic; Endoc. - endocontact; Co.-gr. - coarse-grained; Fi.-gr. - Fine-grained; Med.-gr. - medium-grained; Sm.-bl. - small-block

Table 2. Contents of trace elements (ppm) in K-feldspars of North Carolina pegmatites, their monoclinic (Δ_Z) and triclinic (Δ_p) ordering, and albite content (Ab, weight percent)

Pegmatite field	Specialization of pegmatites	Place of sampling	Texture (zone)	Spec.	Ba	Sr	Rb	Cs	Ba:Rb	Δ_Z	Δ_p	%Ab
Kings Mountain	Raremetal	Foot Mineral Mine	Fi.-gr.	75	48	45	2400	60	0.020	0.91	0.92	15
		Lithium Corporation Mine	Endoc.	89	31	38	1760	132	0.018	0.88	0.80	10
			Co.-gr.	82	10	22	3120	132	0.01	0.97	0.96	0
			Block	84	10	19	3370	198	0.01	0.94	0.92	5
Spruce Pine	Muscovite	Wiseman Mine	Graphic	100	8000	420	280	4	28.6	0.92	0.80	10
			Block	104	2200	230	440	4	5.0	0.97	0.96	15
Spruce Pine	Raremetal-muscovite	Chestnut Flats Mine	Graphic	116	4800	300	376	4	12.0	0.93	0.91	10
			Block	107	720	66	700	16	1.03	0.93	0.95	10
			Block	108	800	67	640	12	1.25	1.0	0.93	5
		McKinney Mine	Apogr.	127	120	44	1168	21	0.103	1.0	0.94	5
			Block	130	130	44	1424	29	0.091	0.97	0.91	5
		Hootowl Mine	Apogr.	134	120	70	936	28	0.128	0.97	0.94	15
			Sm.-bl.	139	160	71	904	17	0.177	0.93	0.97	10
Spruce Pine	Absent	Chalk Mountain	Fi.-gr.	123	310	96	480	4	0.65	0.94	0.94	10
			Med.-gr.	124	420	68	984	14	0.43	0.95	0.98	5
Asheville	Absent	Roadcut	Med.-gr.	140	8000	520	332	tr.*	24.1	0.73	0.40	5
			Co.-gr.	141	8800	620	296	n.d.	29.1	0.53	0.0	5

Abbreviations as follows: tr.=traces; n.d.= not discovered.

ences, the Ba:Rb ratio ranges over three orders of magnitude.

There is a distinction between generations of Kfs similar to differences established at other deposits (Oftedal, 1961; Solodov, 1962; Sretenskaya, 1964). As an example of these relations, compare the three samples of the Feldspar Company pegmatites (Georgia): from the graphic (earliest) zone to the fine block and then to the block (central) zone there is a progressive decrease of Ba and Sr concentrations in Kfs. Rb and Cs increase in the same direction, though not so strongly.

The Strickland quarry Kfs have low Rb concentrations and a higher Ba:Rb ratio, because these results are not for the latest generations of Kfs. This pegmatite is of the raremetal type, containing spodumene,

Table 3. Contents of trace elements (ppm) in K-feldspars of some pegmatites and granites from Black Hills and Medicine Bow, their monoclinic (Δ_Z) and triclinic (Δ_p) ordering, and albite content (Ab, weight percent)

Pegmatite field, state	Specialization of pegmatites	Place of sampling	Texture (zone)	Spec.	Ba	Sr	Rb	Cs	Ba:Rb	Δ_Z	Δ_p	%Ab
Black Hills, South Dakota	Muscovite	New York Mine	Graphic	197	8800	500	376	tr.	23.4	0.92	0.86	5
			Apogr.	202	590	72	5540	128	0.107	0.95	0.95	5
			Apogr.	207	340	140	2610	120	0.130	0.93	0.96	5
			Block	195	20	130	632	132	0.032	0.95	0.94	10
	Raremetal	Hugo Mine	Sm.-bl.	159	42	140	1730	63	0.024	0.95	0.94	15
			Block	167	35	52	3600	748	0.010	0.95	0.92	0
		Etta Mine	Endoc.	169	690	190	1824	644	0.373	0.95	0.92	10
		Tin Queen	Block	194	42	130	1928	92	0.022	0.94	0.91	10
		Tin Mtn.	Block	210	29	100	2336	1360	0.012	0,97	0.99	5
	Absent	Gray Rocks	Sm.-bl.	226	580	190	360	tr.	1.61	0.97	0.95	5
		Willow Creek	Med.-gr.	237	300	100	344	n.d.	0.862	0.91	0.88	20
Medicine Bow, Wyoming	Uranium-rare-earths	State Line vein	Granite	284	7200	170	290	tr.	24.9	0.85	0.80	25
			Endoc.	285	5000	200	405	3	12.4	0.88	0.80	15
			Sm.bl.	288	46	20	550	tr.	0.084	0.90	0.83	35
			Block	290	510	39	1675	15	0.304	0.92	0.86	15
	Absent	Outcrop	Graphic	294	210	80	730	7	0.288	0.95	0.94	10
			Sm.-bl.	295	130	63	780	7	0.167	0.93	0.93	5

lepidolite, amblygonite, lithiophilite, and columbite, and the Cs content is high even in the early generation of Kfs.

As to structural state, all Kfs in Table 1 are maximum microclines. The Δ_z value is usually slightly higher than Δ_p. In three cases the relation is inverted, but the differences are very small and less than measurement error. The Ab content in Kfs is very low except for sample 393 from the raremetal Strickland pegmatite.

The studied Kfs from three North Carolina pegmatite fields (Table 2) are very different in minor-element contents. Again the largest concentrations of Ba and Sr are in Kfs of muscovite pegmatite and of some non-specialized pegmatite veins, which contain abundant magnetite crystals and occur in hypersthene metagabbro in a roadcut not far from Asheville (US Highway 19). In well-known raremetal pegmatites near Kings Mountain (lithium specialization) the Kfs contain maximal Rb and Cs concentrations, but Ba contents are sometimes lower than 0.001 percent (the edge of detectability), and in the region as a whole the Ba:Rb value has three-order variation.

The differences of Kfs generations in one vein are easily seen (see specimen pairs 89 and 84, 100 and 104, 116 and 107, Table 2). However, zones similar in time of origin have the analogous geochemical characteristic of Kfs (for instance, apographic and block textures). Contents of minor elements are identical in samples 107 and 108 taken 40 cm apart in the central and peripheral parts of a big Kfs crystal. The raremetal–muscovite pegmatite veins of one pegmatite field (Spruce Pine) can be similar in Kfs composition (McKinney and Hootowl mines) or slightly different, particularly in Ba contents (see Chestnut Flats mine, analogous to muscovite pegmatite in some respects).

Almost all specimens of Kfs in Table 2 show a very high degree of monoclinic and triclinic ordering, though samples 89 and 100, which are from earliest Kfs generations, show a slight reduction of Δ_p. Two specimens, 140 and 141, however, stand out sharply from the rest. These two samples, from the Asheville pegmatites, have to be designated intermediate microcline (#140) and intermediate orthoclase (#141). The reasons for this anomaly are the high Ba concentrations and the absence of intensive postmagmatic processes in those pegmatites. This question will be discussed later.

The Ab content is low in all Kfs specimens of Table 2.

Table 3 presents Kfs of Precambrian pegmatites in South Dakota and Wyoming. These pegmatites differ widely in specialization. The elevated Ba and Sr content in the earliest Kfs generation of muscovite pegmatite is very close to that of similar pegmatites in Appalachians. Kfs of the State Line uranium–rare-earth pegmatite also show high Ba concentrations. Such pegmatites are more deep-seated than muscovite ones. In raremetal pegmatites the contents of Rb and particularly Cs in Kfs are high, but Ba concentrations and the Ba:Rb value are very low.

Sharply higher Rb and Cs concentrations in apographic Kfs from muscovite pegmatites at the New York mine are uncommon. This pegmatite vein is unique in several respects (thickness of block zone, albite and beryl abundance, some lithium mineralization) and is abnormal for typical muscovite pegmatites. Nevertheless, the New York mine must be classified as a muscovite (and not raremetal–muscovite) pegmatite, in view of the large quantity and good quality of mica mined there (Redden, 1963).

X-ray investigations show that every Kfs of Table 3 is maximum microcline. Some decrease of Δ_p value is noticed in Ba-rich specimens 197, 284, and 285, plus specimen 288 containing 35 percent Ab. The samples of State Line pegmatite all have a higher Ab content than most others.

Table 4 is devoted to Kfs of Colorado pegmatites, which, though variously mineralized (Landes, 1935), are mostly without commercial deposits except for ceramic raw materials. We don't see here large Ba and Sr contents as in the Kfs of muscovite pegmatites, or high Rb and Cs concentrations as in the Kfs of raremetal pegmatites. Differences between veins and between generations particularly are manifested, and the Ba:Rb value decreases strongly (1–2 orders) from the early Kfs generations to the latest ones.

Two specimens of druse Kfs are interesting. One can compare them with Kfs surrounding block pegmatite. The druse feldspar of the White Cloud vein differs by its lower Ab content and Ba concentration, and the monoclinic and especially triclinic ordering is greater. The main difference in the Rosking druse Kfs is a sharply elevated Rb (and Cs) concentration; its triclinicity is even lower than that of the surrounding block feldspar.

There are many Kfs samples with a low degree of ordering in Table 4, and they include all studied specimens of the White Cloud, Huge, and Rosking veins. These samples contain as a rule not less than 15 percent Ab and elevated quantities of Rb or Ba. But the rubidium and barium concentrations in speci-

Table 4. Contents of trace elements (ppm) in K-feldspars of Colorado pegmatites, their monoclinic (Δ_Z) and triclinic (Δ_p) ordering, and albite content (Ab, weight percent)

Pegmatite field	Specialization of pegmatites	Place of sampling	Texture (zone)	Spec.	Ba	Sr	Rb	Cs	Ba:Rb	Δ_Z	Δ_p	%Ab
South Platte	Rare-earths	White Cloude Mine	Granite	251	1700	150	304	n.d.	5.60	0.91	0.78	50
			Graphic	252	580	71	480	tr.	1.21	0.80	0.81	30
			Sm.-bl.	253	160	23	470	tr.	0.341	0.71	0.40	25
			Block	256	140	25	1112	30	0.126	0.77	0.0	25
			Druse	256/1	20	22	1312	44	0.015	0.97	0.87	15
	Absent	Roadcut	Block	265	550	100	370	tr.	1.49	0.97	0.95	5
			Graphic	266	600	68	220	tr.	2.73	0.93	0.95	5
Devils Head	Absent	Huge vein	Granite	361	3800	180	250	n.d.	15.2	0.82	0.40	15
			Fi.-gr.	358	170	46	715	9	0.24	0.85	0.58	15
		Rosking Vein	Block	352	29	13	648	tr.	0.045	0.85	0.80	25
			Druse	353	44	33	3062	33	0.014	0.90	0.68	25
Buckhorn Canyon	Absent	Roadcut	Graphic	280	2700	160	330	7	8.18	0.94	0.92	15
			Block	282	310	73	500	17	0.62	0.95	0.93	10
			Block	273	76	66	1050	29	0.072	0.90	0.86	20
Glen Haven	Absent	Roadcut	Apogr.	309	100	31	520	12	0.192	0.94	0.86	15
			Graphic	316	1600	170	390	12	4.10	1.0	0.95	10
			Sm.-bl.	321	270	66	375	20	0.72	0.97	0.92	30
		Outcrop	Med.-gr.	324	1400	160	440	3	3.18	0.91	0.93	10
			Med.-gr.	329	1500	160	465	3	3.23	0.95	0.94	15
Prairie Divide	Absent	Topaz Prospect	Sm.-bl.	333	110	67	780	4	0.141	0.95	0.98	20
			Block	337	35	27	2075	42	0.017	0.95	0.96	20

mens 253, 358, and 352 are not unusual, and heightened Ab contents in Kfs from other veins (see ## 321, 333, 337) do not correlate with their ordering.

Discussion

In spite of many investigations dealing with composition and structure of Kfs, many questions of their crystallochemistry are not answered. The feldspar world is one of metastable crystal lattices undergoing many ordering and disordering processes. It is a family of solid solutions of several main components and scores of isomorphic elements (Ribbe, 1975).

The objectives of this paper are to compare Kfs of some U.S. pegmatites with earlier-studied examples from other regions and to explain several discrepancies from the established generalizations.

Data in Tables 1–4 show first of all that the main features of Kfs composition of the pegmatites studied are the same as those of Indian, East Siberian, and Karelian pegmatites (Gordienko and Leonova, 1976; Shmakin, 1976). The Kfs of muscovite pegmatites are characterized by high Ba and Sr contents, raremetal pegmatites by high Rb and Cs contents. The Kfs of raremetal-muscovite pegmatites have an intermediate composition. The Ba:Rb ratio in the earliest generations of Kfs shows well the geochemical (and commercial) specialization of pegmatites. Increase of Rb and Cs contents and decrease of Ba and Sr occurred during the formation of all pegmatites studied.

There are limits of fluctuation of Ba and Rb contents for early Kfs (endocontact rims, graphic and fine-grained textures) in Table 5. Kfs of the same pegmatite class in the U.S., India, and Eastern Siberia are amazingly similar. (Note that all results

Table 5. Limits of Ba and Rb contents (weight percent), and Ba:Rb ratios for the earliest K-feldspar generations from pegmatites of different types in three pegmatite regions

Region	Muscovite pegmatites			Raremetal-muscovite pegmatites			Raremetal pegmatites		
	Ba	Rb	Ba:Rb	Ba	Rb	Ba:Rb	Ba	Rb	Ba:Rb
U.S.A.	0.06–0.9	0.03–0.04	18–30	0.1–0.5	0.04–0.06	3–13	0.003–0.07	0.07–0.2	0.02–0.4
India	0.2–1.1	0.02–0.08	10–50	0.04–0.5	0.04–0.08	0.7–10	0.002–0.02	0.1–0.4	0.05–0.2
East Siberia	0.6–1.3	0.02–0.05	12–50	0.05–0.5	0.04–0.10	5–12	0.005–0.10	0.05–1.5	0.02–2.0

used here were obtained by the same analytical methods in the A. P. Vinogradov Institute of Geochemistry.) The obvious similarities in the level of Ba and Rb concentrations depend of course not on regional reasons but on the similar composition of magma and analogous conditions of pegmatite formation.

The essential geochemical distinctions between pegmatites of different specialization are caused mainly by conditions of magma differentiation, and contents of trace elements on Kfs depend apparently on temperature and pressure at the time of crystallization. Since the temperatures of beginning crystallization are quite similar for all granite pegmatites, the pressure value can be considered as the main factor of minor-element concentrations in the feldspar structure.

Geological data suggested that muscovite pegmatites formed at a depth of 5–8 km, and the raremetal pegmatites formed at 3.5–5 km (Ginzburg and Rodionov, 1960). Studies of gas–liquid inclusions in minerals have confirmed such differences and gave for magmatic muscovite pegmatites 5.7–7.7 kbar initial pressure (Shmakin and Makagon, 1972) and for raremetal pegmatites 1.5–4 kbar (Bazarov and Motorina, 1969; Makagon, 1974). Evidently raremetal–muscovite pegmatites begin to form at 4–5.5 kbar pressure.

Shmakin (1971) suggested that increase of pressure of Kfs crystallization must promote Ba (and Sr) isomorphic replacements but hinder those of Rb (and Cs). A detailed investigation of Kfs containing Ba shows a reduction of unit-cell size as a result of isomorphism $Ba^{2+} + \square \rightarrow 2K^{+}$ (Afonina *et al.*, 1973). This fact indirectly supports the above-mentioned suggestion. With decrease of temperature, and consequently of volatile-produced pressure, such an isomorphism becomes more difficult, but the isomorphism $Rb(Cs) \rightarrow K$, to the contrary, is facilitated. Therefore, reduction of the Ba:Rb value in successive generations of Kfs seems to be generally true.

For Kfs generations of similar formation time the Ba:Rb ratio can be used as an indicator of pressure and geochemical specialization. This ratio, instead of K:Rb, was proposed as a sensitive geochemical indicator for rocks (Heier and Adams, 1964). We can see now that for potassium minerals such an indicator may be well-grounded, because of the rules governing isomorphism. Table 5 shows that the variation of Ba:Rb values for Kfs of the three pegmatite types hardly overlap, so this is a valid discriminant for pegmatite type.

Data on structural states and Ab contents in Kfs are of definite interest. Side by side with predominant maximum microclines among the studied Kfs are orthoclases and high and intermediate microclines. As was mentioned above, they are characterized by elevated concentrations of Ba (samples 140 and 141, Table 2; 361, Table 4), Rb and/or Ab (samples 253, 256, 353, Table 4). There is only one specimen, 358 (Table 4) from the Huge mine, where reduced triclinicity is not correlated with high contents of trace elements.

The influence of Na, Ba, Rb, and Cs as "hinderers" of the ordering process in the Kfs crystal lattice has been mentioned previously (MacKenzie, 1954; Frondel *et al.*, 1966; Gordienko and Kamentsev, 1967; Afonina and Shmakin, 1970). The presence of "strange" elements in the structure is obviously a negative factor when a metastable monoclinic Kfs modification changes spontaneously into a stable triclinic one. But the influence of intensive ordering factors (tectonic processes, postmagmatic replacement, radiation, *etc.*) can cause triclinization even in Kfs crystals containing a high quantity of trace elements (Shmakin *et al.*, 1975). Such factors apparently explain the rather high Δ_z and Δ_p values in samples 13, 15 (Table 1), 75–84, 100 (Table 2), 197, 202, 207, 167, 210, 284, 285 (Table 3), 280 and 337 (Table 4), which contain elevated Ba and Rb. The same reasons may apply to specimens 393 (Table 1), 288 (Table 3), and 321 (Table 4) containing 30–35 percent Ab.

It is noteworthy that Kfs samples from the Asheville pegmatites (Table 2) and from muscovite pegmatites in the Wiseman (Table 2) and New York (Table 3) mines have similar levels of Ba content but a different ordering. The Asheville veins were not altered by postmagmatic processes, whereas in the muscovite pegmatites postmagmatic processes were very intensive. The "hinder" effect of Ba in Kfs of muscovite pegmatites is as a rule noticeable where Ba is more than 1 percent (Makagon and Shmakin, 1970).

The mentioned exception, *viz.*, that specimen 358 (Table 4) has $\Delta_p = 0.58$ and normal contents of trace elements, may be explained by the absence of intensive postmagmatic processes in the Huge pegmatite. The Ba content in Kfs of the exocontact granite (sample 361) is also too low to explain a Δ_p value of 0.40. These two specimens are in a metastable structural state. When there is no ordering influence, then even a low Ab content (15 percent) may be a sufficient hindrance for spontaneous ordering.

Conclusions

(1) The maximal contents of Ba (0.6–0.9 percent) and Sr (0.04–06 percent) are characteristic of primary Kfs of muscovite pegmatites and some other deep-seated pegmatite veins.

(2) For primary Kfs, the maximal concentrations of Rb (near 0.2 percent) and Cs (more than 0.01 percent) are in raremetal pegmatites.

(3) In successive generations of Kfs in pegmatites of both the muscovite and raremetal types, there is an increase of Rb (and Cs) and a decrease of Ba (and Sr) contents.

(4) The value of the Ba:Rb ratio for the earliest generations of Kfs can be an indicator of geochemical specialization of granite pegmatites.

(5) Trace-element concentrations in Kfs from the U.S., India, and Eastern Siberia are very similar in pegmatites of the same class.

(6) The pressure of pegmatite formation can promote or prevent the isomorphic substitution of one or the other element for K in Kfs.

(7) Most of the Kfs from U.S. pegmatites are maximum microclines. Structures of orthoclase and high or intermediate microcline are characteristic of Kfs containing high Ab contents or Ba and Rb concentrations from pegmatites that have not been affected by intensive postmagmatic processes.

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