

Kalipyrochlore, a new mineral of the pyrochlore group

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Abstract

Kalipyrochlore, from the Lueshe carbonatite, Zaire, was described but not named in 1965. The name was introduced by the IMA Subcommittee on Nomenclature of the Pyrochlore Group (Hogarth, 1977) for a pyrochlore species in which potassium is the most abundant A atom. Analyzed kalipyrochlore from Lueshe has $a = 10.56-10.59\text{Å}$, $G(\text{meas}) = 3.40-3.48$, $G(\text{calc}) = 3.40-3.44$, $n = 1.93-1.99$. The mean of two closely similar analyses gives the formula $(\text{K}_{0.18}\text{Sr}_{0.07}\text{Na}_{0.04}\text{Ca}_{0.01})(\text{Nb}_{1.82}\text{Ti}_{0.18}\text{Zr}_{0.02})\text{O}_{6.13}[(\text{H}_2\text{O})_{1.43}\text{F}_{0.04}]$, after correction for inclusions and omitting minor constituents.

Introduction

Recently, Hogarth (1977) presented a new classification and chemical nomenclature of the pyrochlore group for the IMA Subcommittee on this group of minerals. By definition, the minerals belonging to the pyrochlore group are characterized by essential amounts of Nb, Ta, and Ti either individually or in combination, the space group $Fd3m$, a pyrochlore structure and the general formula $\text{A}_{2-m}\text{B}_2\text{O}_6(\text{O,OH,F})_{1-n} \cdot p\text{H}_2\text{O}$. At the suggestion of Michael Fleischer, a brief description of kalipyrochlore will be given, because the original publication is no longer accessible to most mineralogists. Kalipyrochlore was described by Van Wambeke (1965) under the name weathered pyrochlore. At that time the mineral did not receive a name, because there was an urgent need for a complete revision of the nomenclature of the pyrochlore group.

Occurrence

Kalipyrochlore was found in the alluvial deposits, and is common in the residual soils of the Lueshe carbonatite deposit, Kivu, Zaire. The niobium mineralization is characterized by Na-Ca pyrochlores in the unweathered sövites, by lueshite associated with vermiculite in some fenites, by columbite often associated with fersmite, both pseudomorphous after pyrochlore in the residual soils of the northwest part of the deposit.

Kalipyrochlore occurs in greenish octahedra, some of which are corroded (mean size 3 to 5mm, maxi-

imum 10mm). The main inclusions are ilmenite, rutile, and barian goyazite. The inclusions have been isolated by magnetic and gravimetric separations and studied by microscopy and X-ray diffraction and fluorescence. The SrO/BaO ratio of barian goyazite varies between 6.5 and 4.5, but this mineral is not always present as inclusions in kalipyrochlore.

Physical properties

Specific gravity measurements (Berman balance), corrected for mineral impurities, gave values which are in good agreement with those calculated. They are summarized in Table 1 and compared with analyzed pyrochlores from the same deposit. The refractive indices of kalipyrochlore range from 1.93 to 1.99, lower than the values for the Na-Ca pyrochlore. The hardness of kalipyrochlore varies between 4 and 4½. The partially weathered pyrochlore was shown to

Table 1. Density and refractive indices of kalipyrochlores and pyrochlores (Lueshe deposit)

Pyrochlore species	G(meas)	G(calc)	n
Analyzed Na-Ca pyrochlores	4.05-4.18	4.11-4.20	2.04-2.15
Partially weathered pyrochlore	3.75		1.98 (external zone) 2.09 (internal zone)
Analyzed kalipyrochlore P _{VI}	3.48	3.44	1.985
Analyzed kalipyrochlore P _{VII}	3.42	3.40	1.95
Other kalipyrochlores	3.40		1.97

Table 2. Chemical analyses of partially weathered pyrochlore and kalipyrochlore from Lueshe

Elements analyzed	Partially weathered green pyrochlore P _v Partial analysis of the mineral	Green kalipyrochlore P _{vI}		Greenish white kalipyrochlore P _{vII}	
		Analysis of the mineral	Analysis corrected for impurities and reduced to 100% *	Analysis of the mineral	Analysis corrected for impurities and reduced to 100% *
Na ₂ O	3.81	0.29	0.35	0.50	0.58
K ₂ O	1.0	2.3	2.73	2.35	2.76
CaO	8.6	0.84	0.41	1.0	0.13
BaO	0.2	0.43	0.28	0.53	0.38
SrO	2.10	3.8	2.60	3.1	1.73
MgO		0.1	0.11	0.1	0.11
FeO		0.7	0.06	0.7	0.07
MnO		0.07	0.08	0.05	0.06
ThO ₂		0.11	0.12	0.15	0.17
U ₃ O ₈		0.09	0.10	0.07	0.08
PbO		0.01	0.01	0.02	0.02
Ce ₂ O ₃		0.22	0.26	0.21	0.25
La ₂ O ₃		0.08	0.10	0.11	0.13
Nd ₂ O ₃		0.025	0.03	0.04	0.045
Pr ₂ O ₃		0.025	0.03	0.04	0.045
Sm ₂ O ₃		n. d.	--	n. a.	--
Y ₂ O ₃		0.006	0.007	0.02	0.022
Gd ₂ O ₃		n. d.	--	0.009	0.01
Nb ₂ O ₅		66.40	78.60	68.2	80.05
Ta ₂ O ₅		0.05	0.06	0.1	0.11
V ₂ O ₅		0.021	0.023	0.029	0.033
TiO ₂		5.6	4.10	5.5	4.12
ZrO ₂		0.56	0.66	0.31	0.37
SnO ₂		n. a.	--	0.05	0.06
Fe ₂ O ₃		0.73	0.20	0.53	0.13
Al ₂ O ₃		3.0	0.18	2.7	--
F	1.1	0.32	0.38	0.1	0.11
H ₂ O+ 110°C	4.1	9.9	8.54	10.1	8.37
H ₂ O- 110°C		1.65	--	0.27	--
CO ₂		0.4	--	0.7	--
SiO ₂		0.3	--	0.22	--
P ₂ O ₅		2.3	--	2.3	--
		100.327 O=F 0.135 100.192		100.108 O=F 0.042 100.066	
	Mineral impurities	Mineral impurities		Mineral impurities	
	Rutile,	Goyazite	7.8%	Goyazite	7.5%
	Ilmenite,	Ilmenite	2.0%	Ilmenite	1.9%
	Fluorapatite,	Rutile, Brookite, Anatase	1.3%	Rutile, Anatase	1.1%
	Calcite	Calcite	0.9%	Calcite	1.6%
		Kaolinite	0.55%	Kaolinite	0.4%
		Goethite	0.3%	Goethite	0.2%
		Traces of aegirite			

* Analyses corrected also for excess of absorbed water which disappears around 130°C.

consist of an internal zone of Na–Ca pyrochlore and an external zone of kalipyrochlore (see also X-ray data).

Kalipyrochlore belongs to the space group $Fd\bar{3}m$ with a cell edge varying between 10.56 and 10.59 Å ($a = 10.584 \pm 0.004$ Å and $a = 10.580 \pm 0.004$ Å for the analyzed kalipyrochlores P_{VI} and P_{VII} respectively). These values are much higher than those found for the Lueshe pyrochlore (10.41–10.42 Å). The partially weathered pyrochlore gave a value of 10.415 Å for the internal zone corresponding to pyrochlore, and a value of 10.585 Å for the external zone formed by kalipyrochlore.

The DTA curve of kalipyrochlore is very similar to that of bariopyrochlore (Jäger *et al.*, 1959, van der Veen, 1963). It shows an endothermic peak at 325°C (dehydration peak) and exothermic reactions at 560°C and 860°C.

Chemical composition

Table 2 gives chemical analyses of carefully selected material. These analyses were carried out by N.V. Hollandse Metallurgische Industrie, Billiton. The procedure used for the quantitative determination of the mineral impurities is described in the original publication (Van Wambeke, 1965). The formula, $(K_{0.18}Sr_{0.07}Na_{0.04}Ca_{0.01})(Nb_{1.82}Ti_{0.16}Zr_{0.02})O_{5.13}(H_2O_{1.43}F_{0.04})$, has been derived from the chemical analyses, after correction for inclusions, and omitting minor constituents.

Compared to the general formula of pyrochlore, $A_{2-m}B_2O_6(O,OH,F)_{1-n} \cdot pH_2O$, kalipyrochlore shows

large deficiencies in the *A* positions (only 1/5 to 1/6 of the *A* positions are occupied) and a strong predominance of K over all other atoms. The entry of K with a large ionic radius in the structure and possibly the hydration stage explains the high unit-cell values. The Ca and Na contents are very low, and F is largely replaced by H_2O molecules, as in bariopyrochlore. On the other hand, the atomic proportions in the *B* positions are identical to the analyzed pyrochlores of Lueshe. The two analyzed specimens could be named hydrated strontian kalipyrochlore.

Genesis

Kalipyrochlore is clearly derived from normal pyrochlore by leaching of Na, Ca, and F, and enrichment in K and H_2O . Weathering, most probably by waters rich in K ions, is the main cause leading to the formation of kalipyrochlore, which is found essentially in the residual soils of the deposit.

References

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