American Mineralogist, Volume 63, pages 528–530, 1978

Kalipyrochlore, a new mineral of the pyrochlore group

L. Van Wambeke

Commission des Communautés Européennes
Rue de la Loi 200, 1049 Brussels, Belgium

Abstract

Kalipyrochlore, from the Lueshe carbonatite, Zaire, was described but not named in 1965. The name was introduced by the IMA Subcommission 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 = 10.56–10.59A, G(meas) = 3.40–3.48, G(calc) = 3.40–3.44, n = 1.93–1.99. The mean of two closely similar analyses gives the formula $(K_{0.18}Sr_{0.07}Na_{0.04}Ca_{0.01})(Nb_{1.82}Ti_{0.16}Zr_{0.02})O_{5.13}[(H_2O)_{1.43}F_{0.04}]$, 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 $A_{2-m}B_2O_6(O,OH,F)_{1-n} \cdot pH_2O$. 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, maximum 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

0003-004X/78/0506-0528$02.00

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

Elements analyzed	Partially weathered green pyrochlore P_V	Green kalipyrochlore P_{VI}		Greenish white kalipyrochlore P_{VII}	
	Partial analysis of the mineral	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_2O	3.81	0.29	0.35	0.50	0.58
K_2O	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_3O_8		0.09	0.10	0.07	0.08
PbO		0.01	0.01	0.02	0.02
Ce_2O_3		0.22	0.26	0.21	0.25
La_2O_3		0.08	0.10	0.11	0.13
Nd_2O_3		0.025	0.03	0.04	0.045
Pr_2O_3		0.025	0.03	0.04	0.045
Sm_2O_3		n.d.	--	n.a.	--
Y_2O_3		0.006	0.007	0.02	0.022
Gd_2O_3		n.d.	--	0.009	0.01
Nb_2O_5		66.40	78.60	68.2	80.05
Ta_2O_5		0.05	0.06	0.1	0.11
V_2O_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_2O_3		0.73	0.20	0.53	0.13
Al_2O_3		3.0	0.18	2.7	--
F	1.1	0.32	0.38	0.1	0.11
H_2O+ 110°C	4.1	9.9	8.54	10.1	8.37
H_2O- 110°C		1.65	--	0.27	--
CO_2		0.4	--	0.7	--
SiO_2		0.3	--	0.22	--
P_2O_5		2.3	--	2.3	--
		100.327 O=F 0.135 100.192		100.108 O=F 0.042 100.066	
	Mineral impurities Rutile, Ilmenite, Fluorapatite, Calcite	Mineral impurities Goyazite 7.8% Ilmenite 2.0% Rutile, Brookite, Anatase 1.3% Calcite 0.9% Kaolinite 0.55% Goethite 0.3% Traces of aegirite		Mineral impurities Goyazite 7.5% Ilmenite 1.9% Rutile, Anatase 1.1% Calcite 1.6% Kaolinite 0.4% Goethite 0.2%	

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

Kalipychlore 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

Hogarth, D. D. (1977) Classification and nomenclature of the pyrochlore group. *Am. Mineral., 62,* 403–410.

Jäger, E., E. Niggli and A. H. van der Veen (1959) A hydrated barium-strontium pyrochlore in a biotite rock from Panda Hill, Tanganyika. *Mineral. Mag., 32,* 10–25.

van der Veen, A. H. (1953) A study of pyrochlore. *Verhand. Kon. Ned. Geol. Mijnbouwk. Genootschap., Geol. Serie 22.*

Van Wambeke, L. (1965) A study of some niobium-bearing minerals of the Luesche carbonatite deposit (Kivu, Rep. of Congo). *Euratom Rep. 2110e.*

Manuscript received, October 5, 1977; accepted for publication, December 1, 1977.