

Type-mineralogy of Rwanda with particular reference to the Buranga pegmatite

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(1 figure and 10 tables)

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ABSTRACT. The type-mineralogy of Rwanda is reviewed. Six type-mineral names are presented, comprising four approved valid species and two non-valid phases. An unnamed mineral is also given. The four approved species are described from two type localities: Buranga and Lutsiro. One of these minerals remains unique to the type occurrence. All but one of the described type-phases occur in the Buranga pegmatite, which is host to over hundred other valid species. More than half the recorded minerals from Buranga are phosphates of which two compositional groups are recognised: Al-dominant and Fe-Mn-dominant phases.

KEYWORDS: type-mineralogy, phosphate minerals, Buranga pegmatite, Rwanda.

RESUME. La minéralogie-type du Rwanda avec référence particulière à la pegmatite de Buranga. La minéralogie-type du Rwanda est revue. Six noms de minéraux types sont présentés, comprenant quatre espèces reconnues et 2 phases non reconnues. Un minéral non nommé est aussi donné. Les quatre espèces reconnues provenant de deux localités types sont décrites : Buranga et Lutsiro. Un de ces minéraux reste propre à l'occurrence type. Toutes les phases types décrites, à l'exception d'une d'entre elles, se présentent dans la pegmatite de Buranga qui contient plus de cent autres espèces reconnues. Plus de la moitié des minéraux en provenance de Buranga sont des phosphates que l'on répartit en deux groupes de composition différente : l'un à l'Al dominant et l'autre à Fe-Mn dominants.

MOTS-CLES : minéralogie des espèces types, phosphates, pegmatite de Buranga, Rwanda.

1. Introduction

1.1. Foreword

A review of the type-mineralogy of Rwanda is presented.

This publication is one in a series being produced by one of the authors (VDCD) on the type-mineralogy of Africa.

The listing of type-minerals from Rwanda is as complete as possible, up to the time of publication. The authors however apologize for any omissions which might have arisen during the compilation of this work. Amendments and additions to this effect would be most gratefully received.

1.2. Type-mineral definitions and terminologies

The term type-mineral (or type-mineral species) may be defined as any natural mineral species that is described for the first time and upon which the formal definition of the mineral is made. The locality from which such a mineral is initially described is known as the type-locality. No attempt is made in this publication to subdivide any of the type-species into holotypes, cotypes or neotypes, as defined by Dunn & Mandarino (1988).

The validity (or non-validity) of all the documented minerals is taken in strict accordance with the recommendations of the Commission on New Minerals and Mineral Names (C.N.M.M.N.) of the International Mineralogical Association (I.M.A.). Valid type-mineral are therefore minerals that have been approved by the Commission.

Those minerals or mineral names that either lack formal approval by the Commission or have been rejected by the Commission are referred to as non-valid species. A list of named and unnamed type-minerals from Rwanda is given in Table 1.

Table 1. Recorded type-minerals from Rwanda

Valid Species	Non-Valid Phases
Bertossaite	Ba-arrojadite
Burangaite	Keno-mitridatite
Foordite	
Gatumbaite	
Unnamed Phases	
Hydrated Fe-Mn-OH-phosphate	

1.3. Rwandan overview

Seven type-mineral/mineral names are presented, comprising 4 valid type-species, 2 non-valid phases and 1 unnamed phase. The Buranga pegmatite is host to 3 of the 4 approved mineral species.

2. Type mineralogy

2.1. Type mineralogy of the named phases

Ba-arrojadite



Arrojadite-Dickinsonite series

The name "Ba-arrojadite" was first applied by Bertossa (1969) to the barian arrojadite of von Knorring (1969) from the Buranga pegmatite. "Ba-arrojadite" occurs as yellowish green material, intergrown with pyrite and chalcopyrite.

The phase is an intermediate member of the arrojadite-dickinsonite series in which Ba partly replaces K. The chemical composition of this barian arrojadite is given in Table 2, along with barium-free arrojadite from Buranga and South Dakota and with dickinsonite from Connecticut. The suggested formula given for "Ba-arrojadite" is based on the proposal by Moore & Ito (1979).

A barian arrojadite is also described by Mary Mrose (*in von Knorring, 1969*) as occurring in one of the New Hampshire pegmatites.

Bertossaite



Bertossaite was initially described from the Buranga pegmatite by von Knorring (1965) as an unnamed phase and subsequently named and fully characterised by von Knorring & Mrose (1966). The mineral is the calcium analogue of palermoite. In fact, Povarennykh (1972) uses the term *Ca-palermoite* for a calcian palermoite (locality not stated) thereby suggesting a possible series

Table 2. Compositional data for "Ba-arrojadite", arrojadite and dickinsonite

	1	2	3	4	5
P ₂ O ₅	39.54	39.34	40.52	40.00	39.5
Al ₂ O ₃	2.37	1.96	2.17	2.66	2.0
Fe ₂ O ₃	—	1.34	—	—	—
FeO	46.70	19.36	25.72	28.22	13.3
MgO	—	2.80	0.21	1.04	—
MnO	—	19.45	18.63	15.78	32.0
CaO	2.60	2.28	2.03	2.46	2.3
BaO	—	5.36	—	—	—
Na ₂ O	5.76	4.97	6.27	6.40	7.8
K ₂ O	2.19	0.63	2.49	1.74	1.1
LiO	—	0.20	—	0.09	0.45
H ₂ O ⁺	—	1.45	—	0.91	—
H ₂ O ⁻	—	0.10	—	—	—
H ₂ O	0.84	—	—	—	1.65
F	—	0.47	—	0.80	—
Insol:	—	—	—	0.11	—
	100.00	99.71	98.04	100.21	100.1
Less O = F	—	0.20	—	0.34	—
	100.00	99.51	98.04	99.87	100.1

1. Theoretical arrojadite $\text{KNa}_4\text{CaFe}^{2+}_{14}\text{Al}(\text{OH})_3(\text{PO}_4)_{12}$ (Moore *et al.*, 1981).
2. Barian arrojadite, Buranga (anal. O.v. Knorring, von Knorring, 1969).
3. Arrojadite, Buranga (anal. C. Gilles, Franolet, 1980).
4. Arrojadite, Nickel Plate mine, South Dakota (Lindberg, 1950).
5. Dickinsonite, Branchville, Connecticut (anal. Irving, *in* Moore and Ito, 1979).

between bertossaite and palermoite. Bertossaite occurs as a pale pink, massive material with amblygonite, lazulite-scorzalite, augelite, brazilianite, apatite and crandallite. Masses of bertossaite up to 50 kg have been recovered from the Buranga deposit.

Compositional data for bertossaite are given in Table 3.

Table 3. Compositional data for bertossaite

	1
P ₂ O ₅	45.24
Al ₂ O ₃	33.42
FeO	0.98
MgO	tr
MnO	0.76
CaO	8.36
SrO	tr
BaO	tr
Na ₂ O	0.34
K ₂ O	tr
Li ₂ O	4.21
H ₂ O ⁺	5.36
H ₂ O ⁻	0.07
F	1.68
Insol:	0.27
	100.79
Less O = F	0.71
	100.08

1. Bertossaite, Buranga (anal. O.v. Knorring, von Knorring, 1965).

There is also an unconfirmed occurrence of bertossaite in Uganda.

The phase is named for Antonia Bertossa, past director of the Geological Survey of Rwanda.

Burangaite



Burangaite occurs as bluish to bluish green, hour-glassed zoned, prismatic crystals in the Buranga pegmatite (von Knorring *et al.*, 1977). The phase replaces scorzalite and occurs with bertossaite, trolleite, apatite, bjarebyite and wardite. Burangaite is also described from kyanite-bearing siliceous rocks at Hålsjöberg, Sweden (Nysten, 1990).

Burangaite is the unnamed fibrous, blue mineral of von Knorring (1973). Compositional data for burangaite are given in Table 4. The phase is named for the deposit.

Table 4. Compositional data for burangaite

	1
P ₂ O ₅	37.65
Al ₂ O ₃	34.35
Fe ₂ O ₃	1.14
FeO	6.26
MgO	2.00
MnO	0.40
CaO	1.88
Na ₂ O	2.93
H ₂ O*	11.60
Insol:	2.06
	100.27

1. Burangaite, Buranga (anal. O.v. Knorring, von Knorring *et al.*, 1977).

Foordite



Foordite-Thoreaulite series

Foordite, the niobium analogue of thoreaulite, was initially described from Lutsiro, in the Sebeya River area, Rwanda (Cerny *et al.*, 1988). The phase occurs as brownish-yellow material with a greenish tint and previously thought to be thoreaulite; the holotype specimen is a 30 g subangular pebble from alluvium at Lutsiro, where it occurs in contact with stannous plumbomicrocline, cassiterite, ferro-columbite, stannite and ixiolite. Foordite from Lutsiro is in fact a lead-bearing variety (see Table 5).

Table 5. Compositional data for foordite

	1	2
SnO	33.63	25.4
PbO	—	6.0
Ta ₂ O ₅	—	28.7
Nb ₂ O ₅	66.37	40.1
	100.00	100.2

1. Foordite, theoretical composition.

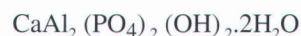
2. Foordite, holotype, Lutsiro, Rwanda (Cerny *et al.*, 1988).

The phase is isostructural with thoreaulite and its crystal structure has more recently been refined by Ercit & Cerny (1988).

Cerny *et al.* (1988) also confirm that the so-called thoreaulite from Kubitaka, Punia district, Kivu province, Zaire, corresponds to foordite, thereby representing a second occurrence. The Kubitaka material is designated as the cotype specimen.

Named for Eugene E. Foord who suggested the existence of the phase; the name should not be confused with froodite of Hawley & Berry (1958) a natural palladium bismuthide from Sudbury, Ontario.

Gatumbaite



Described by von Knorring & Fransolet (1977) from the Buranga pegmatite, Gatumba district, as white, millimetric sheaves and rosettes with trolleite, scorzalite, apatite and bjarebyite. Gatumbaite is the unnamed Ca-Fe phosphate phase of von Knorring (1972). Compositional data for gatumbaite are given in Table 6.

Table 6. Compositional data for gatumbaite

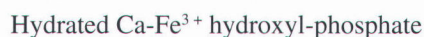
	1	2
P ₂ O ₅	40.24	41.35
Al ₂ O ₃	30.34	28.09
Fe ₂ O ₃	—	2.20
MnO	—	0.30
CaO	16.70	17.35
Na ₂ O	—	0.30
H ₂ O*	10.72	10.68
H ₂ O ⁻	—	0.32
	100.00	100.59

1. Gatumbaite, theoretical composition.

2. Gatumbaite, Buranga (anal. O.v. Knorring, von Knorring & Fransolet, 1977).

Gatumbaite is also reported from the Palermo No.1 pegmatite, New Hampshire (Segeler *et al.*, 1981) and at Hålsjöberg, Sweden (Nysten, 1990). The phase is named for the mining district of Gatumba, in which the Buranga deposit is located.

Keno-mitridatite



A name suggested by Van Wambeke (1971) for relatively unoxidised mitridatite from the Buranga pegmatite, Rwanda and the Kobokobo pegmatite, Kivu province, Zaire. The prefix **keno** is taken from a proposal by Permingeat (*in* Van Wambeke, 1971) who suggests it as a prefix modifier for cation-deficient members belonging to the pyrochlore group. The phase is named for its relationship to mitridatite.

2.2. Mineralogy of the unnamed phases

Hydrated Fe-Mn-OH-phosphate



A brown to yellowish-brown fibrous, dufrenite-like mineral is mentioned by von Knorring & Sahama

(1982). The mineral is compositionally-similar to dufrenite, though the powder patterns are comparable to those of the souzalite-gormanite series. von Knorring & Sahama (1982) have suggested that the mineral may represent the manganese analogue of the unnamed phase of Frondel (1949) from Waldgirmes, Germany.

The phase thus far remains inadequately characterised.

2.3. Mineralogy of previously unknown phases

A number of unidentifiable phases have been described from Buranga. Several of these have turned out to be new mineral species (viz: bertossaite, burangaite and gatumbaite) whereas others have now been identified with previously known species; the latter group comprise the following:

Ba-Mn-Fe-Al phosphate (=bjarebyite)

A pistachio-green to dark green, striated phase found intergrown with bertossaite (von Knorring, 1969, 1973); this phase was recognised by one of the authors (OvK) as early as 1964. An identical mineral was later described from the Palermo mine, New Hampshire by Mary Mrose (U.S.G.Q.) who provisionally named it **ashleyite**, after Mr. Ashley the mine owner at Palermo. The phase is bjarebyite (von Knorring & Fransolet, 1975) which was in fact named and fully characterised by Moore *et al.* (1973). Analytical data for bjarebyite from Buranga are given in Table 10.

Ba-Ca-Mn-Al-Fe-OH-phosphate (= samuelsonite)

Described as a greenish-yellow, fibrous mineral associated with lazulite-scorzalite in trolleite (von Knorring, 1972, 1973). The phase was subsequently identified as samuelsonite by Fransolet *et al.* (1992) and is perhaps the second recorded occurrence of the mineral. Compositional data for samuelsonite are given in Table 10.

Na-Li-Al phosphate (= lacroixite)

Described by Fransolet & Abraham (1983) as a replacement of montebasite. The phase is identical with lacroixite which was first recognised at Buranga by one of the authors (OvK).

3. Topographical mineralogy

3.1. General trends

A total of 292 valid type-minerals are documented for Africa for the period 1838-1988 (Daltry, 1991) though this number has now increased to over 310. In this context, Rwanda ranks equal 12th (with Algeria) in terms of numbers of valid type-species per country, as summarised in Table 7.

The four approved phases are described from just two type-localities, viz: the Buranga pegmatite and the Lutsiro Sn alluvial deposit (fig. 1). Three of the approved phases are phosphate minerals, whereas foordite is a complex oxide.

Table 7. Geographical ranking for approved African type-minerals.

Ranking	Country	Number of type-species	Source
1	Zaire	91	Daltry, 1992a
2	Namibia	61	Daltry, 1992b
2	South Africa	61	Daltry & Dixon (in press)
4	Morocco	15	Daltry, 1991
5	Madagascar	11	ibid.
6	Gabon	9	ibid.
7	Kenya	7	ibid.
7	Uganda	7	ibid.
7	Zambia	7	Daltry, 1992c
10	Zimbabwe	5	Daltry (in press)
10	Tanzania	5	Daltry, 1991
12	Rwanda	4	this paper
12	Algeria	4	Daltry, 1991

3.2. Buranga mineralogy

The Buranga pegmatite is situated just north of Gatumba, in Gisenyi province and lies some 50 km west of Kigali, the capital.

The Buranga granite pegmatite is one of a number of pegmatites in the region, which intersect rocks of the Precambrian Burundian system. The Buranga pegmatite is however, the most diverse source for Rwandan minerals. One hundred and five approved mineral species have been documented from the pegmatite (Tab. 8) mainly through the studies of Polinard (1950); Thoreau & Delhal (1950); Thoreau (1954); Thoreau & Bastien (1954a, 1954b); Thoreau & Safiannikoff (1957); van Wambeke (1957); Altmann (1961); Van Tassel (1961); Gallagher & Gerrards (1963); Bertossa (1960, 1965, 1966, 1968, 1969); von Knorring (1969); von Knorring & Fransolet (1977); von Knorring & Sahama

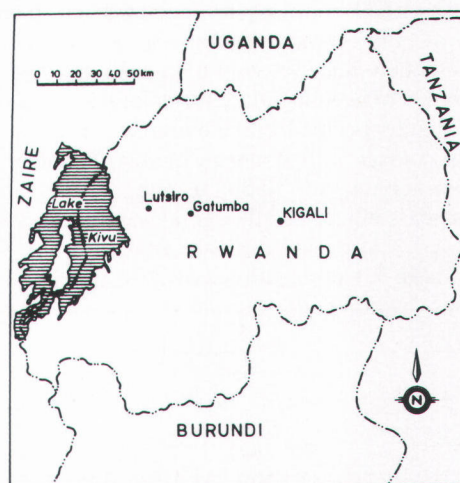


Figure 1. Type-locality map for Rwanda

Table 8. Mineralogy of the Buranga pegmatite

Valid Species		
Native Elements	Sulphides	
Bismuth	Bismuthinite Chalcopyrite Sphalerite	Marcasite Pyrite Galena
Oxides		
Cassiterite	Goethite	Pyrochlore
Columbite	Magnetite	Tantalite
Cryptomelane	Manganotantalite	Thoreaulite
Fergusonite-(Y)	Microlite	Uranmicrolite?
Carbonates	Arsenates	Tungstates
Bismutite	Scorodite	Scheelite
Cerussite		
Phosphates		
Alluaudite	Ferrisicklerite	Phosphosiderite
Amblygonite	Fillowite	Purpurite
Apatite (s.l.)	Fluorapatite	Rockbridgeite
Arrojadite	Frondelite	Samuelsonite
Attakolite	Gatumbaite	Scorzalite
Angelite	Graftonite	Sicklerite
Autunite	Griphite	Stewartite
Barbosalite	Heterosite	Strengite
Berlinite	Hureaulite	Tavorite
Bermanite	Lacroixite	Triphylite
Bertossaite	Landesite	Triplite
Bjarebyite	Lazulite	Trolleite
Brazilianite	Leucophosphate	Variscite
Burangaite	Lipscombite	Varulite
Cacoxenite	Lithiophilite	Vivianite
Childrenite	Mitridatite	Wardite
Crandallite	Monazite-(Ce)	Wavellite
Dufrenite	Montebrasite	Eosphorite
Natromontebrasite?		
Silicates		
Actinolite	Hornblende (s.l.)	Quartz
Albite	Lepidolite	Rhodonite
Anorthoclase	Microcline	Schorl
Apophyllite	Muscovite	Siderophyllite
Beryl	Oligoclase	Spodumene
Biotite	Opal	Talc
Cancrinite	Orthoclase	Topaz
Elbaite	Paragonite	Zinnwaldite
Epidote	Phlogopite	Zircon
Non-Valid Phases		
	Amethyst	Limonite
	Ashleyite	Malacon
	(= bjarebyite)	
	Ba-arrojadite	Manganoapatite
	Cleavelandite	Martite
	Clinostrengite	Metastrengite
	Fremontite	Oncosine
	Gummite	Quartz (chalcedony)
	Hyaline quartz	Rose quartz
	Keno-mitridatite	Smoky quartz
	Killinite	Wad

(1982); Fransolet (1975; 1989); Boury (1980-1981); Fransolet *et al.* (1992). The pegmatite is particularly noted for its rich variety of phosphates minerals (55 species). In this regard, the Buranga pegmatite must rank as one of the world's most renowned sources for phosphate species.

Reviews on the genesis of phosphate mineralisation at Buranga are given by Fransolet (1975), Boury (1980-1981) and von Knorring & Sahama (1982).

Two distinct compositional groups of phosphates can be recognised at Buranga, based on dominant-cation associations. These are the Mn-Fe-dominant- (Al-free) phases and the Al-dominant phases. The Al-dominant minerals may be further subdivided into Al-Mn-Fe phases and those phases comprising of Al + other metals \pm Fe-Mn. Minerals comprising each group are tabulated (Tab. 9). It should be stressed that no paragenetic relationship is inferred from this two-fold division of the phosphates. Analytical data for the various phosphates from Buranga are given in Table 10.

Table 9. Al-free and Al-dominant phosphate mineral groups from Buranga

Al-free groups	
Mn:	Bermanite
Mn-Fe:	Frondelite, Heterosite, Hureaulite, Landesite, Lipscombite, Purpurite, Rockbridgeite, Stewartite
Mn-Fe-Li:	Ferrisicklerite, Lithiophilite, Triphylite, Sicklerite
Mn-Fe-Na:	Alluaudite, Arrojadite, Fillowite
Mn-Fe-Ca:	Graftonite
Mn-Fe-Ca-Na:	Varulite
Mn-Fe-Ca-Mg:	Triplite
Fe:	Barbosalite, Cacoxenite, Dufrenite, Vivianite, Phosphosiderite
Fe-Li:	Tavorite
Fe-K:	Leucophosphate
Fe-Ca:	Mitridatite
Aluminium-dominant group	
Al-Mn-Fe \pm alkali earths subgroup	
Al-Mn-Fe:	Childrenite, Eosphorite
Al-Mn-Fe-Ba:	Bjarebyite
Al-Mn-Fe-Ca:	Samuelsonite
Al-Mn-Fe-Ca-Li-Na:	Bertossaite
Al-Mn-Fe-Ca-Na:	Griphite
Al \pm alkali \pm alkali earth \pm Fe \pm Mn subgroup	
Al:	Angelite, Berlinite, Trolleite, Variscite, Wavellite
Al-Li:	Amblygonite, Montebrasite
Al-Na:	Brazilianite, Lacroixite
Al-Na-Li:	Natromontebrasite
Al-Ca:	Crandallite, Gatumbaite
Al-Ca-Na:	Wardite
Al-Fe-Mg:	Lazulite, Scorzalite
Al-Mn-Ca:	Attakolite
Al-Fe-Ca-Mg-Na:	Burangaite

Table 10. Mineral analyses for selected Buranga phosphate minerals

	1	2	3	4	5	6	7	8	9
P ₂ O ₅	44.33	43.19	45.63	38.76	42.21	30.97	30.69	32.96	42.76
Al ₂ O ₃	—	1.31	45.55	42.53	—	21.77	21.50	13.25	6.37
Fe ₂ O ₃	0.00	6.42	0.25	0.24	28.22	—	—	3.3	1.48
FeO	14.94	3.64	—	—	1.33	16.59	10.63	5.94	7.26
MnO	30.74	17.23	—	—	20.20	13.55	20.30	15.98	8.81
MgO	0.06	0.47	nd	tr	0.61	0.07	0.07	—	—
CaO	0.10	1.31	0.40	—	0.60	0.09	0.07	—	26.96
Na ₂ O	0.04	4.94	0.20	8.10	0.08	—	—	—	0.44
K ₂ O	—	0.00	nd	0.18	0.17	—	—	—	0.07
Li ₂ O	9.00	0.04	nd	0.01	2.78	—	—	—	0.42
H ₂ O	—	—	—	—	—	—	—	4.7	—
H ₂ O ⁺	0.14	0.88	6.66	9.33	3.24	—	—	—	1.88
H ₂ O ⁻	—	—	0.18	—	—	—	—	—	0.03
Insol.	0.63	0.81	—	0.94	0.60	—	—	—	0.28
SiO ₂	—	—	0.90	—	—	—	—	—	—
Total	99.98	100.24	99.77	100.09	100.04	83.04	83.26	100.00	99.41

1. Lithiophilite (anal. J.M. Speetjens, *in* Fransolet, 1975)
2. Alluaudite (*in* Fransolet, 1975)
3. Trolleite (anal. O.v. Knorring, *in* Fransolet, 1975)
4. Brazilianite (anal. J.M. Speetjens, *in* Fransolet, 1975)
5. Ferrisicklerite (anal. J.M. Speetjens, *in* Fransolet, 1980)
6. Manganooan childrenite (anal. C. Gilles, *in* Fransolet, 1980)
7. Eosphorite (anal. C. Gilles, *in* Fransolet, 1980)
8. Bjarebyite (anal. O. v. Knorring, *in* von Knorring & Fransolet, 1975)
9. Samuelsonite (anal. O. v. Knorring, *in* Fransolet *et al.* 1992)

4. Acknowledgements

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