

BURANGAITE, A NEW PHOSPHATE MINERAL FROM RWANDA

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This paper describes a new phosphate, burangaite, from the Buranga pegmatite in Rwanda.

Burangaite is monoclinic with the idealized formula $(\text{Na,Ca})_2(\text{Fe}^{2+},\text{Mg})_2\text{Al}_{10}(\text{OH},\text{O})_{12}(\text{PO}_4)_8 \cdot 4\text{H}_2\text{O}$, $Z = 2$. The crystals exhibit narrow, bladed prisms, elongated parallel to the b -axis. Perfect cleavage parallel to 100 . Mohs' hardness 5. Streak slightly bluish. Unit-cell data: a_0 25.09 Å, b_0 5.048 Å, c_0 13.45 Å, β 110.91°, space group $C2/c$. These parameters and the indexed X-ray powder pattern (Table 1) indicate a marked relationship with dufrenite.

The mineral is blue in color with $\gamma \parallel b$ and $c \wedge a = 11^\circ$, $2V_a = 58^\circ$, strong pleochroism, refractive indices α 1.611, β 1.635, γ 1.643. Common hourglass structure with a blue core and a colorless margin.

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Introduction

The occurrence of a long-prismatic bluish phosphate mineral from the Buranga pegmatite, Rwanda, was noted and provisionally described by one of us (von Knorring 1973). This mineral appears to be confined to corroded aggregates of bertossaite (von Knorring and Mrose 1966), trolleite, scorzalite (identified chemically and by X-ray powder pattern) and quartz. It forms either a replacement product of scorzalite which it closely resembles, or conspicuous bluish-green radiating crystals, with distinct dichroism, set in white, fibrous late-stage apatite, and it is

commonly associated with bjarebyite (von Knorring and Fransolet 1975), wardite and other phosphates under study. Wardite occurs as white crystals of pyramidal habit, up to 2 mm in size, with dominating $\{012\}$ and $\{013\}$, narrow $\{011\}$ and with small $\{001\}$ and $\{110\}$. Its X-ray powder pattern matches that published by Lindberg (1957).

At an early stage of the investigation, it was observed that the unknown bluish phosphate mineral resembled souzalite from the Corrego Frio pegmatite in Brazil, described by Pecora and Fahey (1949), but no similarity was found between the powder patterns of the two minerals. The Buranga mineral

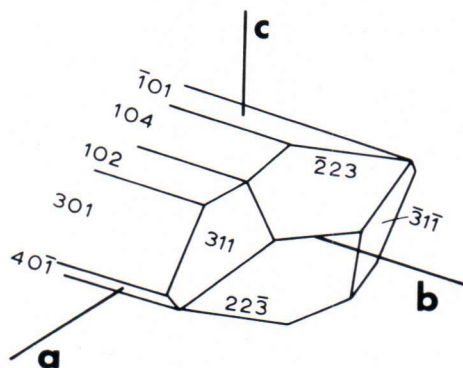
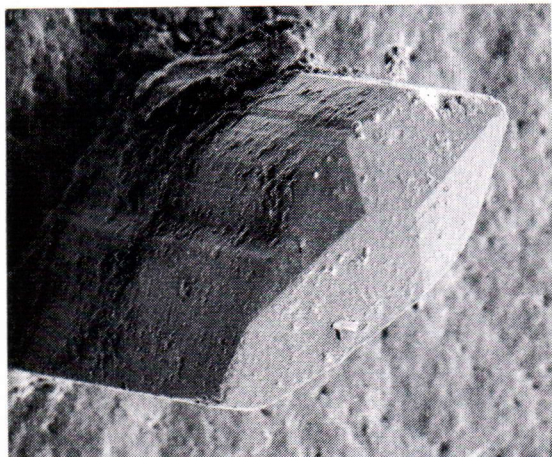


Fig. 1. Crystal habit of burangaite from the Buranga pegmatite, Rwanda. A. Scanning electron micrograph. x 200. B. Idealized crystal form.

represents a new phosphate species here named burangaite according to the locality. The properties of this mineral are presented in this paper. The name has been approved by the Commission on New Minerals and Mineral Names of the International Mineralogical Association.

Crystal morphology

The long prismatic crystals of burangaite are characteristically bladed in appearance, with crystallographic *b* as the prism axis. The

habit is illustrated in Fig. 1 A. The faces of this crystal were smooth enough to allow identification. Fig. 1 B reproduces the idealized crystal form with the assigned indices. The mineral exhibits a perfect cleavage parallel to 100 .

Crystal geometry

Burangaite is monoclinic. Its X-ray powder pattern is reproduced in Table 1. The calculated indexing of the powder lines was checked on the basis of the series of *b*- and *c*-axis X-ray precession photographs. The powder pattern of burangaite resembles markedly that of dufrenite as presented by Moore (1970). The systematic extinctions found in the X-ray single-crystal photographs agree with the space group $C2/c$. The powder data of Table 1 were used for least-squares refinement of the cell parameters. Table 2 summarizes the unit-cell data for burangaite, dufrenite and souzalite. With respect to the cell data, burangaite is related to dufrenite rather than to souzalite.

Chemistry

The material subjected to wet chemical analysis (200 mg) was picked by hand under a binocular microscope and is considered pure. The result of the analysis is summarized in Table 3 which gives also the unit-cell content calculated on the basis of the cell volume and density. In addition, the table indicates the composition of the associated scorzalite. When the idealized formula derived from the chemical composition of burangaite is compared with Moore's (1970) of souzalite and Cornish dufrenite, the following relationship are noted:

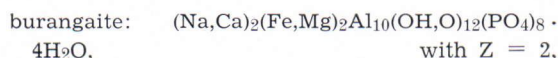


Table 1. X-ray powder pattern of burangaite. Philips wide angle goniometer, nickel filtered copper radiation, internal corundum standard.

| h k l | d (meas.) | d (calc.) | I | h k l | d (meas.) | d (calc.) | I |
|----------|--------------|--------------|-----|----------|--------------|--------------|----|
| 2 0 0 | 11.71 x | 11.72 | 100 | 10 0 0 | | {2.344 | |
| - 2 0 2 | 6.61 x | 6.60 | 20 | 0 2 2 | 2.339 b | {2.342 | 12 |
| 0 0 2 | 6.28 | 6.28 | 5 | - 5 1 5 | | {2.340 | |
| 4 0 0 | 5.86 x | 5.86 | 11 | - 4 2 1 | | {2.339 | |
| 1 1 0 | 4.94 x | 4.93 | 18 | - 10 0 4 | 2.314 | {2.316 | 3 |
| 2 0 2 | 4.86 x | 4.86 | 41 | 9 1 0 | | {2.314 | |
| - 3 1 1 | 4.281 x | 4.276 | 8 | - 4 0 6 | 2.239 b | {2.241 | 4 |
| - 1 1 2 | 4.026 | {4.030 | 30 | 2 2 2 | | {2.240 | |
| - 6 0 2 | | {4.023 | | 1 1 5 | 2.174 | 2.169 | 3 |
| 6 0 0 | 3.904 x | 3.906 | 10 | 0 0 6 | 2.091 b | {2.094 | 6 |
| 3 1 1 | 3.801 x | 3.800 | 11 | - 8 0 6 | | {2.093 | |
| 4 0 2 | 3.682 x | 3.679 | 3 | - 12 0 2 | | {2.088 | |
| - 5 1 1 | 3.559 x | 3.559 | 10 | 4 2 2 | 2.079 | {2.081 | 3 |
| 5 1 0 | 3.436 | 3.435 | 2 | - 11 1 2 | | {2.078 | |
| - 1 1 3 | 3.318 x | {3.318 | 39 | - 9 1 5 | 2.058 | {2.058 | 9 |
| - 3 1 3 | | {3.318 | | 7 1 3 | | {2.057 | |
| 0 0 4 | 3.141 x | 3.140 | 25 | - 11 1 3 | | {2.056 | |
| - 8 0 2 | 3.115 | {3.115 | 70 | - 11 1 1 | 2.044 x | 2.045 | 32 |
| 5 1 1 | | {3.113 | | - 2 2 4 | 2.016 | 2.015 | 10 |
| 1 1 3 | 3.081 x | {3.081 | 90 | 12 0 0 | 1.9537 x | 1.9531 | 10 |
| - 5 1 3 | | {3.080 | | 2 0 6 | 1.9434 | {1.9443 | 15 |
| 8 0 0 | 2.928 x | 2.930 | 12 | - 10 0 6 | | {1.9436 | |
| - 7 1 1 | 2.913 x | 2.913 | 26 | 8 2 0 | 1.9136 | 1.9122 | 6 |
| 6 0 2 | 2.884 | 2.887 | 11 | 6 2 2 | 1.9001 x | 1.9002 | 6 |
| - 3 1 4 | 2.794 x | {2.796 | 22 | 8 0 4 | 1.8402 | 1.8396 | 4 |
| 2 0 4 | | {2.794 | | - 5 1 7 | 1.7934 | 1.7948 | 2 |
| 7 1 0 | | {2.790 | | | 1.7624 | | 2 |
| - 8 0 4 | 2.670 | 2.670 | 2 | | 1.7199 | | 3 |
| 7 1 1 | 2.568 | {2.567 | 20 | | 1.6966 | | 10 |
| 1 1 4 | | {2.564 | | | 1.6746 | | 28 |
| 0 2 0 | 2.524 x | 2.524 | 8 | | 1.6587 | | 2 |
| - 10 0 2 | 2.509 | 2.509 | 2 | | 1.6401 | | 2 |
| - 9 1 1 | 2.417 x | 2.417 | 5 | | 1.6101 | | 7 |
| 2 2 1 | 2.388 | 2.387 | 4 | | 1.5580 | | 10 |
| - 3 1 5 | 2.371 | {2.372 | 5 | | 1.5403 | | 12 |
| 5 1 3 | | {2.369 | | | 1.5147 | | 2 |
| - 9 1 3 | | {2.368 | | | 1.4578 | | 3 |
| 8 0 2 | 2.353 x | 2.353 | 13 | | 1.4435 | | 2 |

b = broad line. x = used for calculating the unit-cell parameters.

dufrenite: $\text{Ca} \cdot 5 \text{Fe}_{12}(\text{OH})_{12}(\text{PO}_4)_8 \cdot 4\text{H}_2\text{O}$, Z = 2
 souzalite: $(\text{Mg},\text{Fe})_6(\text{Al},\text{Fe})_8(\text{OH})_{12}(\text{PO}_4)_8 \cdot 4\text{H}_2\text{O}$, Z = 1

Table 2. Unit-cell data for burangaite, dufrenite and souzalite. Uncertainty of the last decimal in parentheses.

| | Burangaite. This paper. | Dufrenite. Moore (1970). | Souzalite. Moore (1970). |
|-------------|----------------------------|--------------------------------|--------------------------------|
| a_0 (Å) | 25.09 (1) | 25.84 (2) | 12.58 |
| b_0 (Å) | 5.048 (3) | 5.126 (3) | 5.10 |
| c_0 (Å) | 13.45 (1) | 13.78 (1) | 13.48 |
| β | 110.91° (8) | 111.20° (6) | 113.0° |
| Space group | C2/c | C2/c | A2/m or A2 |

Optical and physical properties

The optical orientation of burangaite is $\gamma \parallel b, c \wedge a = 11^\circ$ in the acute angle β . Strong pleochroism with α light blue, β dark blue,

Table 3. Chemical composition of burangaite and associated scorzalite. Analyst. O. von Knorring.

| | Burangaite. Wt. % | Burangaite. Unit-cell content. | Scorzalite. Wt. % |
|--------------------------------|----------------------|--------------------------------------|----------------------|
| Al ₂ O ₃ | 34.35 | Al 20.05 | 30.25 |
| Fe ₂ O ₃ | 1.14 | Fe ³⁺ 0.43 | — |
| FeO | 6.26 | Fe ²⁺ 2.59 | 16.37 |
| MnO | 0.40 | Mn 0.17 | 0.85 |
| MgO | 2.00 | Mg 1.48 | 2.90 |
| CaO | 1.88 | Ca 1.00 | 0.80 |
| Na ₂ O | 2.93 | Na 2.81 | — |
| P ₂ O ₅ | 37.65 | P 15.79 | 41.96 |
| H ₂ O ⁺ | 11.60 | H 38.33 | 5.60 |
| Insoluble | 2.06 | O 96.00 | 1.41 |
| Totals | 100.27 | | 100.14 |
| Density† | 3.05 | | 3.30 |

† By suspension in Clerici solution.

γ colorless, absorption $\beta > \alpha > \gamma$. $2V_{\alpha} = 58^{\circ}$ (calculated 60°) with dispersion $r > v$. Refractive indices: $\alpha = 1.611 \pm 0.002$, $\beta = 1.635 \pm 0.002$, $\gamma = 1.643 \pm 0.001$. Crystals often show an hourglass structure with a blue core and colorless margin. A microprobe test indicated slightly higher Fe and Mn contents in the core than in the margin. Streak weakly bluish. Mohs' hardness 5.

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