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Ranunculite, $AlH(UO_2)(PO_4)(OH)_3 \cdot 4H_2O$, a new mineral[1]

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SUMMARY. Ranunculite occurs as gold-yellow nodules. Mean diameter = 0.3 mm. Optically biaxial negative, 2V (calc.) = 56°. $\gamma = 1.670$, $\beta = 1.664$, and $\alpha = 1.643$. Monoclinic, pseudo-orthorhombic with $a = 11.1$ Å, $b = 17.7$ Å, $c = 18.0$ Å, and $\beta \simeq 90°$. $Z = 14$. Measured density = 3.4 g/cm^3. Calculated density = 3.39 g/cm^3. The strongest lines of the X-ray powder pattern are (*d*, *hkl*, *I*): 9.00, 002-020 (100), 3.133, 330 (80), 4.70, 202-220 (50), 2.978, 006-060 (40), and 1.850, 600 (40). Chemical analysis by electron microprobe: Al_2O_3 9.9%, UO_3 54.5%, P_2O_5 13.2%, H_2O by thermogravimetry 20.3%. Formula: $AlH(UO_2)(PO_4)(OH)_3 \cdot 4H_2O$. Ranunculite occurs at Kobokobo, Kivu, Zaïre, in pegmatitic rocks. The name after the colour (ranunculus = buttercup).

RANUNCULITE has been found at Kobokobo (Kivu, Zaïre). The mineral occurs in uranium-rich portions of a pegmatite mainly worked for beryl and columbite. Meta-autunite, phosphuranylite, as well as several new aluminium-uranyl phosphates have been recognized, associated with ranunculite in the yellow coatings of the rock. Preliminary descriptions of the new aluminium-uranyl phosphates have been summarized in a recent paper (Deliens and Piret, 1977). Ranunculite was designated as 'mineral E'. Together with 'minerals A, B, and H' in the same paper, mineral E has recently been accepted by the Commission on new minerals and new mineral names of the IMA, respectively, as ranunculite, phuralumite, upalite, and threadgoldite.

Physical properties. Ranunculite occurs as gold-yellow nodules. The colour is characteristic of the species and permits its distinction from the other aluminium-uranyl phosphates of the deposit, the colour of which being less bright. The mean diameter of the nodules is 0.3 mm; larger sizes up to 1 mm are unusual. The nodules may be contiguous, then forming botryoidal crusts. Ranunculite is not fluorescent but several samples are covered by a white coating that fluoresces in green under UV light. The Mohs hardness is near 3. The density measured by flotation in heavy liquids is 3.4 g/cm^3. The nodules may carry millimetre-sized crystals of canary-yellow prisms of phuralumite (Deliens and Piret, 1979*a*, in press). Scanning electron photographs show the nodules to be constituted by juxtaposed tabular plates (fig. 1).

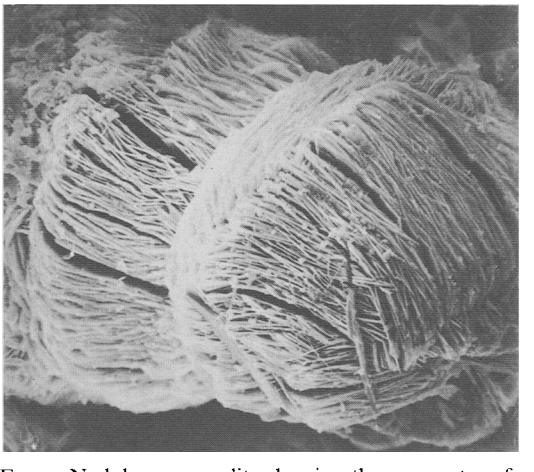

FIG. 1. Nodular ranunculite showing the aggregates of lamellar crystals (Scanning electron photograph, × 800).

[1] This paper is part III of the series 'The uranyl and aluminium phosphates from Kobokobo' (Deliens and Piret, 1977, 1979*a*, *b*).

TABLE I. *Chemical analysis of ranunculite*

	1 Weight meas.	2 per cent 100%	3 Millimolec.	4 Cations	5 Anions	6 No. of atoms for O = 13	7 Theort. per cent
Al_2O_3	9.9	10.1	0.099	0.198	0.297	1.02 Al	9.9
UO_3	54.5	55.6	0.194	0.194	0.582	1.00 U	55.4
P_2O_5	13.2	13.5	0.095	0.190	0.475	0.98 P	13.8
H_2O	20.3	20.8	1.156		1.156		20.9
Total	97.9	100.0			2.510		100.0

The often-observed fibroradiate disposition of nodular aggregates is not present here. Ranunculite is relatively abundant in the specimens from the uraniferous zone of the Kobokobo pegmatite. It exists on fifteen samples in the mineralogical collection of the Musée royal de l'Afrique centrale.

Optical properties. When crushed, ranunculite nodules disaggregate into thin plates with rounded outline. In transmitted light the mineral is strongly pleochroic. Refractive indices in the plane of the plates: $\alpha = 1.643 \pm 0.002$ (pale greenish yellow) and $\gamma = 1.670 \pm 0.002$. $\beta = 1.664 \pm 0.002$ (pale yellow) is perpendicular to the section. Ranunculite is biaxial negative with 2V (calc.) = 56°. The extinction is oblique to the elongation of the plates.

Chemical composition. Qualitative chemical analysis by electron microprobe show uranium, aluminium, and phosphorus without any other element, even in traces. Quantitative analysis by electron microprobe (ARL apparatus of the Laboratoire de Pétrographie de l'Université Catholique de Louvain, analyst J. Wautier) has been performed with the following standards: meta-torbernite for uranium; kyanite, sapphire, and synthetic glass for aluminium; apatite for phosphorus. Water measured by thermogravimetry (D. T. G. Stone, analyst M. Delvigne, MRAC). The results are given in Table I with respectively: the measured weight percentages (1), the total at 100% (2), the number of millimolecules (3), the number of cations (4) and of anions (5), the number of atoms based on O = 13 (6), and the theoretical percentages calculated from the formula $AlH(UO)_2(PO_4)(OH)_3 \cdot 4H_2O$ (7). The partition between (OH) and (H_2O), deduced from the thermogravimetric analysis (fig. 2), has been taken into account for the construction of the formula. Indeed, the disappearance of one water molecule corresponds to a theoretical loss of weight of 3.48%. The curve on fig. 2 shows a rapid and simultaneous loss of weight of 13.3% that corresponds to the disappearance of four molecules of H_2O. The formula $AlH(UO_2)(PO_4)(OH)_3 \cdot 4H_2O$

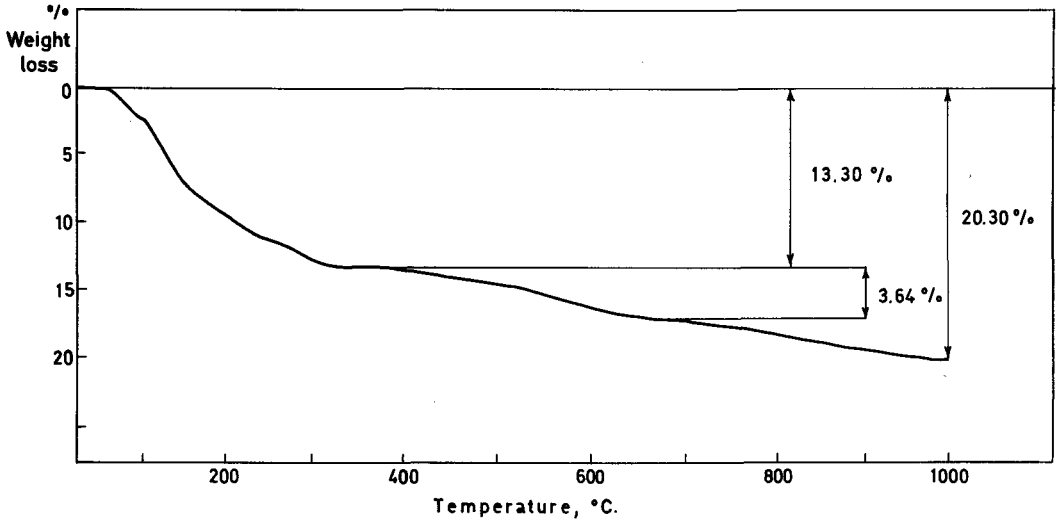

FIG. 2. Differential thermogravimetric analysis of ranunculite.

thus seems to be more appropriate than the former $Al(UO_2)(PO_4)(OH)_2 \cdot 5.5H_2O$ that was mentioned for 'mineral E' in the preliminary paper (Deliens and Piret, 1977). Ranunculite is slowly soluble in 1:1 HNO_3 and fairly soluble in hot 1:1 HCl.

TABLE II. *X-ray powder data for ranunculite:* Cu-$K\alpha$ *radiation,* Ni *filter, 114.6 mm camera*

$d_{mes.}$ (Å)	$I_{vis.}$	$d_{calc.}$ (Å)	*hkl*
9.00	100 B	9.00	002
		8.85	020
6.37	3	6.31	022
5.87	5	5.90	030
5.52	5	5.55	200
4.70	50	4.72	202
		4.70	220
4.45	30	4.43	040
4.02	10 B	4.01	024
3.53	20	3.54	050
3.34	20	3.34	025
3.133	80	3.135	330
2.978	40 B	3.000	006
		2.950	060
2.828	5	2.838	340
		2.803	062
2.629	20	2.647	063
2.529	15	2.529	070
2.207	10	2.203	510
2.098	5 B	2.111	307
		2.088	370
2.055	5	2.055	280
1.928	5	1.921	092
1.883	3	1.881	550
1.850	40	1.850	600
1.741	10 B	1.748	408
		1.736	390
1.573	15 B	1.575	606

X-ray data. X-ray powder pattern of ranunculite is given in Table II. The spectrum differs from those of the other uranyl-aluminium phosphates and particularly from sabugalite $AlH(UO_2)_4(PO_4)_4 \cdot 16H_2O$ and threadgoldite $AlH(UO_2)_2(PO_4)_2(OH)_2 \cdot 8H_2O$ (Deliens and Piret, 1979*b*, in press). It has not been possible to isolate single crystals, owing to the small size of the plates. Nevertheless very small plates (0.1 × 0.1 × 0.01 mm) gave spectra with characteristics intermediate between those of single crystal and of fibres. The plates are flattened on [010] and possess irregular cleavages parallel to [001] and [100].

Rotation-oscillation, Weissenberg, and precession spectra show an orthorhombic symmetry. However, the oblique extinction towards *a* and *c* (extinction ∧ [001] near 20°) suggests the monoclinic, pseudo-orthorhombic system. The cell dimensions are: $a = 11.10$ Å, $b = 17.7$ Å, $c = 18.0$ Å, $\alpha = \gamma = 90°$, β near 90°. Cell volume of 3536 Å^3. Space group not determined. There are fourteen $AlH(UO_2)(PO_4)(OH)_3 \cdot 4H_2O$ units of formula in the cell. Density measured in heavy liquids = 3.4 g/cm^3. Calculated density 3.39 g/cm^3. The X-ray powder pattern of ranunculite has no analogy with those of the minerals of the autunite and meta-autunite groups. It is probable that the structure is also different.

Nomenclature. The name ranunculite has been given to recall the characteristic gold-yellow colour of the mineral (Latin ranunculus = buttercup). The holotype specimen is preserved in the mineralogical collection of the Musée royal de l'Afrique centrale, B 1980 Tervuren, Belgium. It is registered RGM 6201.

The new mineral and the name have been approved by the Commission on new minerals and mineral names of the IMA by votes 17-1 with one abstention and 18-0 with one abstention, respectively (November 1978).

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