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RITTMANNITE, A NEW MINERAL SPECIES OF THE WHITEITE GROUP FROM THE MANGUALDE GRANITIC PEGMATITE, PORTUGAL

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ABSTRACT

Rittmannite, a new mineral species, is the MnMnFe analog of whiteite. It was found in altered phosphatic "nodules" from the Mangualde granitic pegmatite, Portugal, as very small (0.3 × 0.3 × 0.04 mm), pale yellow, tabular, pseudohexagonal crystals forming aggregates of subparallel individual crystals. It occurs on kryzhanovskite, frondelite, hureaulite and adularia. Rittmannite is monoclinic, space group $P2/a$, a 15.01(4), b 6.89(3), c 10.16(3) Å, β 112.82(25)°, V 968(4) Å^3. The strongest lines in the X-ray powder-diffraction pattern [d in Å(I_{obs})(hkl)] are: 9.38(S)(001), 4.69(mS)(002), 2.802(S)($\bar{2}22$). Electron-microprobe data lead to the composition: MgO 1.5, Al_2O_3 1.3, CaO 3.3, FeO 10.4, Fe_2O_3 (calc.) 2.6, MnO 18.9, P_2O_5 35.9, H_2O (calc.) 19.7, total 103.6 wt.%, corresponding to the formula: $(Mn_{0.54}Ca_{0.47})_{\Sigma 1.01}Mn_{1.00}(Fe^{2+}_{1.15}Mn_{0.56}Mg_{0.29})_{\Sigma 2.00}(Al_{1.75}Fe_{0.25})_{\Sigma 2.00}(OH)_{2.02}(PO_4)_4 \cdot 8H_2O$. D_{meas} 2.81(1) g/cm^3, and D_{calc} for $Z = 2$ is 2.83 g/cm^3. Rittmannite is biaxial (+), with α_{meas} 1.622, β_{calc} 1.626. γ_{calc} 1.654 and $2V_{meas}$ 43(2)°: the orientation of the optical indicatrix is: $X//b$, $Z:c$ +7°. No pleochroism was observed. Rittmannite honors Prof. Alfred Rittman (1893–1980), world-famous volcanologist, who contributed to the development of modern mineralogy, petrography and optical microscopy.

Keywords: rittmannite, whiteite group, phosphate, granitic pegmatite, Mangualde, Portugal, new mineral species.

SOMMAIRE

La rittmannite, nouvelle espèce minérale, est l'analogue MnMnFe de la whitéite. Nous l'avons découverte dans des nodules altérés de phosphates dans la pegmatite granitique de Mangualde (Portugal). Elle forme de très petits cristaux tabulaires (0.3 × 0.3 × 0.04 mm) pseudo-hexagonaux jaune pâle en essaims d'individus sub-parallèles. Elle recouvre kryzhanovskite, frondelite, hureaulite et adulaire. La rittmannite est monoclinique, groupe spatial $P2/a$, a 15.01(4), b 6.89(3), c 10.16(3) Å, β 112.82(25)°, V 968(4) Å^3. Les trois raies les plus intenses du cliché de poudre [d en Å(I)(hkl)] sont: 9.38(S)(001), 4.69(mS)(002), 2.802(S)($\bar{2}22$). Les analyses, obtenues par microsonde électronique, donnent: MgO 1.5, Al_2O_3 1.3, CaO 3.3, FeO 10.4, Fe_2O_3 (calculé) 2.6, MnO 18.9, P_2O_5 35.9, H_2O (calculé) 19.7, total 103.6% (par poids), ce qui correspond à la formule $(Mn_{0.54}Ca_{0.47})_{\Sigma 1.01}Mn_{1.00}(Fe^{2+}_{1.15}Mn_{0.56}Mg_{0.29})_{\Sigma 2.00}(Al_{1.75}Fe_{0.25})_{\Sigma 2.00}(OH)_{2.02}(PO_4)_4 \cdot 8H_2O$. Densité mesurée 2.81(1), et calculée pour $Z = 2$, 2.83. La rittmannite est biaxe positive. α_{mes} 1.622, β_{calc} 1.626, γ_{calc} 1.654, $2V_{mes}$ 43(2)°; l'orientation de l'indicatrice optique est: $X//b$, $Z:c$ +7°. Aucun pléochroïsme n'a été décelé. Le nom honore M. le professeur Alfred Rittman (1893–1980), volcanologue de renommée mondiale qui a contribué au développement de la minéralogie, la pétrographie et la microscopie optique.

(Traduit par la Rédaction)

Mots-clés: rittmannite, groupe de la whitéite, phosphate, pegmatite granitique, Mangualde, Portugal, nouvelle espèce minérale.

INTRODUCTION

During a systematic study of the phosphates from the Mangualde granitic pegmatite in the Viseu district, Portugal (Marzoni Fecia di Cossato & Orlandi 1987), a few pale yellow pseudohexagonal crystals were noted. The X-ray powder-diffraction pattern was found not to correspond to that of any known mineral species, although it resembles that of whiteite.

Further mineralogical studies indicated that the mineral is a new manganese–iron–aluminum phosphate belonging to the whiteite group. The new species was named *rittmannite* in honor of Prof. Alfred Rittmann (1893-1980), eminent scientific personality, who became interested early in his career in mineralogy, petrography and optical microscopy. Later he became a world-famous volcanologist known for his classification of volcanic rocks and for his studies on the connection between tectonic style and magmatic trends. He was also author of a novel hypothesis on the origin and the composition of the earth's core.

The mineral and the name have been approved by the Commission on New Minerals and Mineral Names, I.M.A. The holotype material is preserved in the Museo di Storia Naturale of Pisa (4760/89), and the cotype, in the Museo Civico di Storia Naturale of Milano.

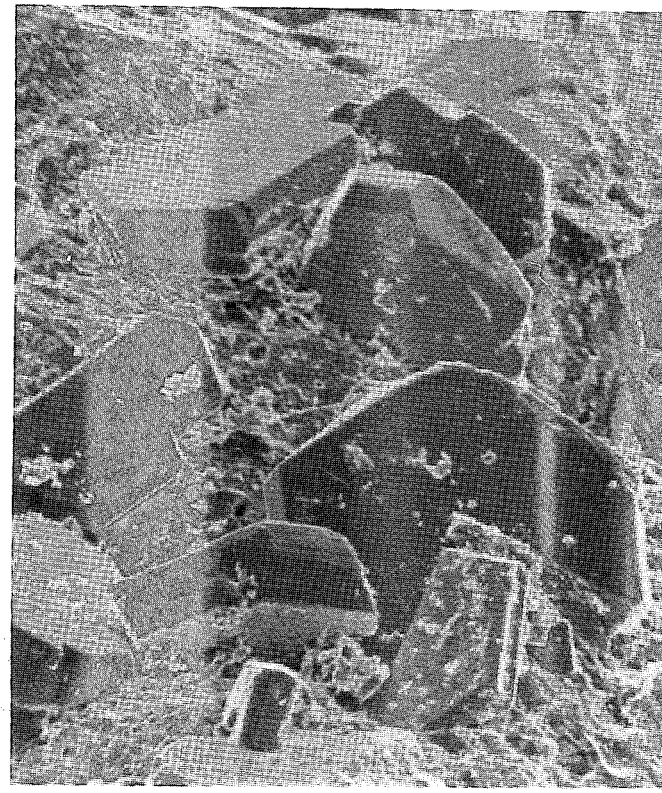

FIG. 1. Rittmannite crystals on massive adularia (SEM photo, 240×).

OCCURRENCE

Mangualde is located in the Viseu district in northern Portugal. Hercinian (post-Stephanian) granites were emplaced in mica schist and gneiss, which outcrop to the south of the village. A complex of zoned veins (up to 11 m thick) of pegmatite cuts the granites. Starting from the granite, their zoning is as follows: an aplitic periphery (2 cm thick), a fine-grained pegmatite with abundant mica, quartz and feldspar (20 cm thick), a coarse-grained pegmatite with smoky quartz, pink orthoclase and white plagioclase (300–350 cm), a coarse-grained pegmatite like the latter, bearing uraniferous micas, Li–Mn–Fe-bearing phosphates ("nodules") and Mn-oxides (800 cm) (De Michele 1969).

Our samples come from phosphatic "nodules" of one of the thicker veins within a two-mica granite, which outcrops in the valley between Mangualde and the hamlet of Mesquitela.

Rittmannite was found on two small (1×1×1 cm) phosphate specimens, consisting of crystallized red-brown, skeletal kryzhanovskite, black needle-like frondelite, pink vitreous hureaulite and white massive adularia (Fig. 1). No mineral is present on rittmannite crystals, suggesting that rittmannite was the last to form in this sequence.

PHYSICAL AND OPTICAL PROPERTIES

About ten crystals of rittmannite were found. They are small, tabular on (001), pseudohexagonal in shape, forming aggregates of subparallel individual crystals. The average crystal dimensions are 0.3×0.3×0.04 mm. Rittmannite crystals are transparent, very pale yellow, with a white streak and vitreous lustre. The estimated Mohs hardness is 3.5. The cleavage, parallel to (001), is indistinct. The density is 2.81(1) g/cm^3 measured using Clerici solution; the calculated value is 2.83 g/cm^3 for $Z=2$.

On the universal stage, in parallel light, rittmannite is biaxial (+), and the orientation of the indicatrix is $X//b$, $Z:c+7°$, with $2V$ 43(2)°. The index of refraction parallel to [100], measured by comparison with liquids of known index in white light, gives $\beta' = 1.628$. The birefringence on (001) is 0.006, so that α is 1.622.

According to Bonatti (1942), from these data, α_{meas} is 1.622. β_{calc} is 1.626, γ_{calc} is 1.654 and $2V_{calc}$ is 42°. No pleochroism was observed.

TABLE 1. X-RAY POWDER-DIFFRACTION DATA FOR RITTMANNITE

I_{obs}	d_{obs}	d_{calc}	hkl
S	9.38	9.37	001
vw	6.22	6.16	110
m	5.66	5.61	$\bar{1}11$
m	4.93	4.91	$\bar{2}11$
m	4.85	4.85	$\bar{2}02$
mS	4.69	4.68	002
mw	4.07	4.08	$\bar{1}12$
w	3.962	3.964	$\bar{2}12$
w	3.888	3.873	012
mw	3.758	3.751	$\bar{4}01$
w	3.571	3.585	$\bar{3}12$
m	3.530	3.507	$\bar{4}02$
m	3.458	3.458	400
m	3.274	3.294	$\bar{4}11$
w	3.208	3.203	311
w	3.125	3.123	003
vw	3.054	3.057	121
vw	2.997	2.995	212
mw	2.957	2.957	$\bar{4}03$
mw	2.896	2.899	401
S	2.802	2.807	$\bar{2}22$
vw	2.758	2.759	320
vw	2.687	2.697	$\bar{5}12$
vw	2.607	2.608	113;122
m	2.558	2.567	510
m	2.344	2.342	004
vw	2.084	2.084	$\bar{3}31$
w	1.989	1.990	
w	1.965	1.968	
m	1.947	1.949	
m	1.884	1.889	

Intensities: S strong, m medium, w weak, vw very weak.

Chemical Composition

Electron-microprobe analyses of rittmannite were performed using the following standards: synthetic calcium phosphate $Ca_2P_2O_7$ for Ca and P, and spessartine for Mn, Fe^{2+}, Al and Mg. The ferrous/ferric ratio of rittmannite could not be measured directly, because insufficient material was available for titration. The fraction of Fe^{3+} was partitioned from FeO_{tot} (12.7%) in order to completely fill the crystal-chemical position occupied by Al^{3+}. For the same reason, the water content could not be determined. The average values obtained from two analyses are: MgO 1.5 Al_2O_3 11.3, CaO 3.3, FeO 10.4, Fe_2O_3 2.6, MnO 18.9, P_2O_5 35.9, H_2O 19.7, total 103.6 wt.%. A high analytical total is a common problem when hydrated minerals are analyzed using the electron microprobe.

The empirical crystal-chemical formula was calculated on the basis of 4 P atoms, according to Moore & Ito (1978): $(Mn_{0.54}Ca_{0.47})_{\Sigma 1.01}Mn_{1.01}(Fe^{2+}_{1.15}Mn_{0.56}Mg_{0.29})_{\Sigma 2.00}(Al_{1.75}Fe_{0.25})_{\Sigma 2.00}(OH)_{2.02}(PO_4)_4 \cdot 8H_2O$. Because of the poor quality of the crystals (aggregates of very thin, subparallel individuals), X-ray structural studies could not be carried out.

X-Ray Crystallography

Weissenberg photographs show that rittmannite is monoclinic with space group $P2/a$ (chosen by analogy with the space group of the jahnsite–whiteite series). The cell parameters a 15.01(4), b 6.89(3), c 10.16(3) Å, β 112.82(25)°, were determined from the X-ray powder-diffraction data (Table 1), obtained using a Gandolfi camera (diameter 114.6 mm) with Fe$K\alpha$ radiation and the least-squares refinement program USGSLSE (Appleman & Evans 1973).

Discussion

From the general formula $XM(1)M(2)_2M(3)_2(OH)_2(H_2O)_8(PO_4)_4$, where X = Ca, Mn; $M(1)$ = Fe, Mn, Mg; $M(2)$ = Fe,Mg,Mn; $M(3)$ = Al^{3+}, Fe^{3+}, Moore & Ito (1978) proposed a nomenclature for the complex jahnsite–whiteite series on the basis of site occupancies in the structure. In jahnsite, the proportion of Fe^{3+} exceeds that of Al^{3+} in $M(3)$; in whiteite, the proportion of Al^{3+} exceeds that of Fe^{3+} in $M(3)$. Moreover, in the whiteite group, the end-members whiteite-(CaFe^{2+}Mg) (type), whiteite-(CaMn^{2+}Mg) and whiteite-(Mn^{2+}Fe^{2+}Mg) are defined by the distribution of cations over the sites X, $M(1)$ and $M(2)$. According to this scheme of classification, rittmannite is the (Mn^{2+}Mn^{2+}Fe^{2+}) member of the whiteite group. Also, it is the first mineral of the series with Fe as a dominant component in the $M(2)$ site.

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