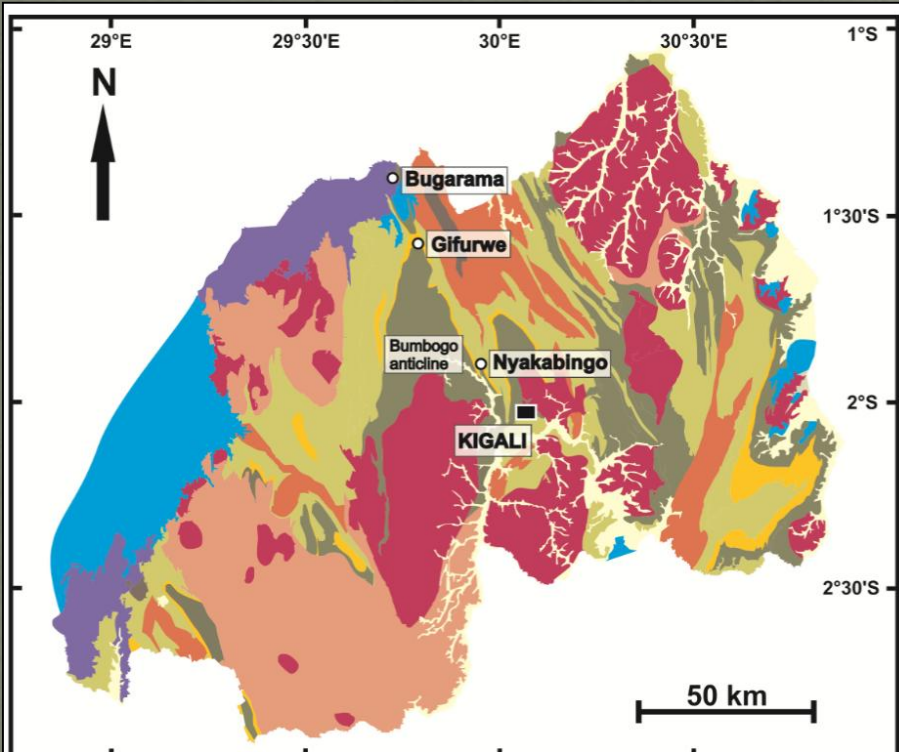


The yttrotungstite group revisited

Prof. Frédéric Hatert

Nanjing, August 22nd, 2026

The Tungsten Belt



© Goldmann *et al.* (2013)

- Quartz veins containing scheelite and ferberite (« wolframite »)
- Alternating with pyrite-bearing black shales (Proterozoic, ~ 992 Ma)

- North of Kigali, Rwanda
- Three deposits of Bugarama, Gifurwe, Nyakabingo

Nyakabingo deposit



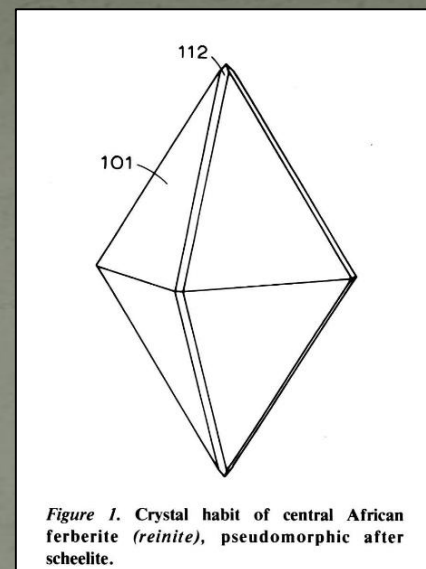
© Dewaele *et al.* (2016)

Primary tungsten minerals



Scheelite, Caogang, China
N° ULiège 40114
© A. Bouvy

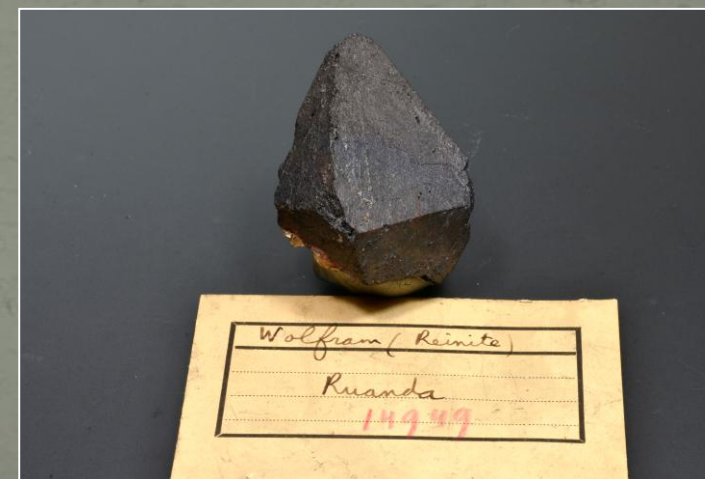
- Scheelite, CaWO_4
- Ferberite, FeWO_4
- Hubnerite, MnWO_4



© Sahama (1981)



Ferberite, Chenzhou, China
© Mindat



« Reinite », Rwanda
N° ULiège 14949
© A. Bouvy

- « Reinite » = pseudomorph of ferberite after scheelite
- Formed during a second mineralization stage

Secondary tungsten minerals

The Secondary Tungsten Minerals, *a Review*

by Th. G. Sahama
Snellmanink. 5
SF-00170 Helsinki
Finland

Sahama (1981)

- Anthoinite, $\text{Al}(\text{WO}_3)(\text{OH})_3$
- Mpororoite $\text{WAlO}_3(\text{OH})_3 \cdot 2\text{H}_2\text{O}$
- Raspite PbWO_4
- Yttrotungstite-(Ce) $\text{CeW}_2\text{O}_6(\text{OH})_3$
- Yttrotungstite-(Y) $\text{YW}_2\text{O}_6(\text{OH})_3$

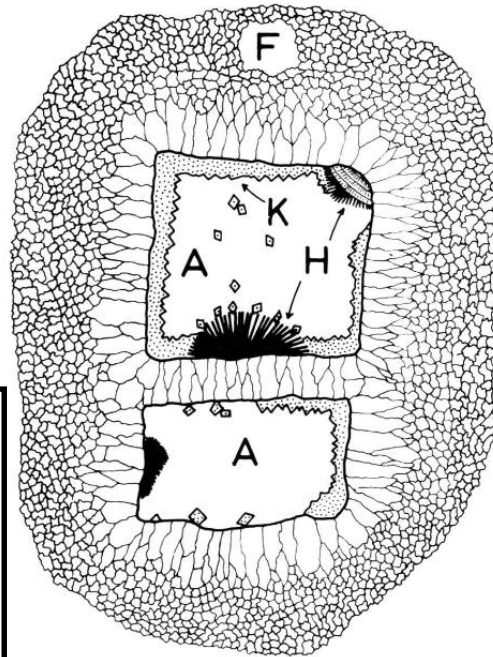
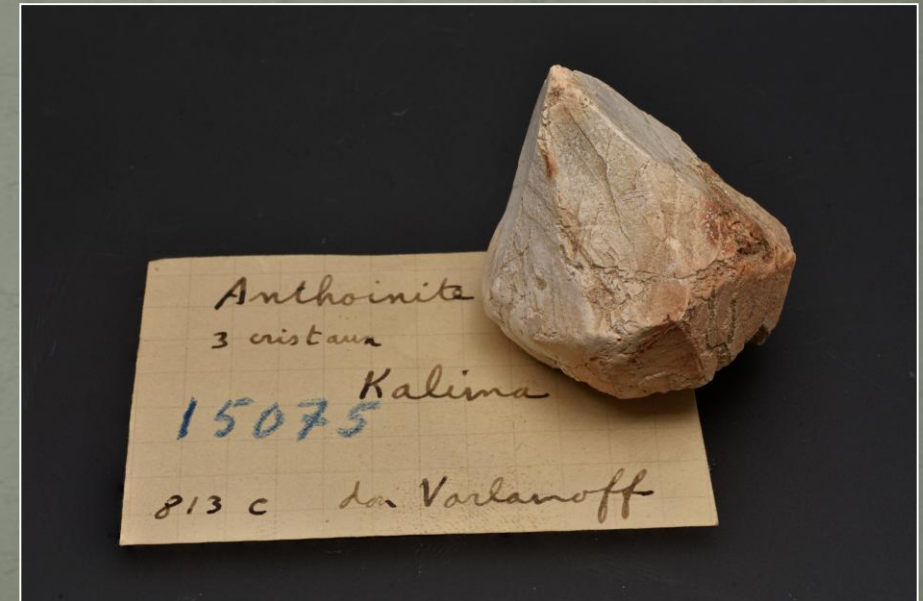


Figure 3. Schematic cross-section of two cavities in ferberite. F = ferberite. K = alumotungstite (ferritungstite). H = cerotungstite. A = anthoinite.

- Tungstite $\text{WO}_3 \cdot \text{H}_2\text{O}$
- Hydrotungstite and meymacite $\text{WO}_3 \cdot 2\text{H}_2\text{O}$
- Hydrokenoelsmoreite $[\text{Al}_2\text{W}_2\text{O}_6(\text{H}_2\text{O})]$ (previously « ferritungstite » and « alumotungstite »)



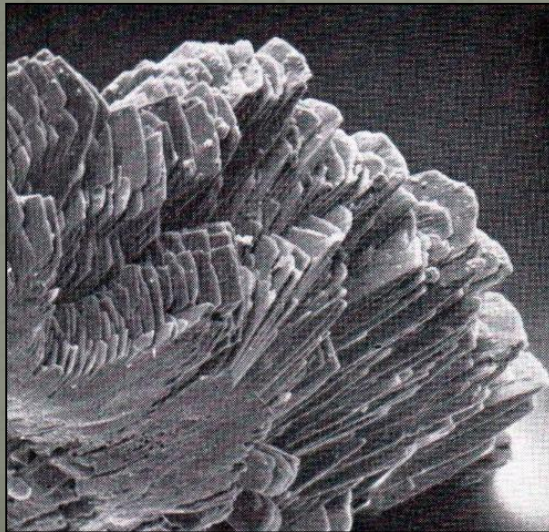
Anthoinite, Kalima, D.R. Congo
ULiège 15075, © A. Bouvy

The yttrotungstite group



Kramat Pulai mine, Malaysia

© Mindat



Kigezi District, Uganda

MINERALOGICAL MAGAZINE

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Yttrotungstite

R. J. DAVIS

Mineralogy Department, British Museum (Natural History), Cromwell Road, London, S.W. 7

AND G. W. SMITH

British Petroleum Co. Ltd., B.P. Research Centre, Sunbury-on-Thames, Middlesex

Davis & Smith (1971)

- « Yttrotungstite » renamed yttrotungstite-(Y)
- « Cerotungstite » renamed yttrotungstite-(Ce)

Nickel & Mandarino (1987)

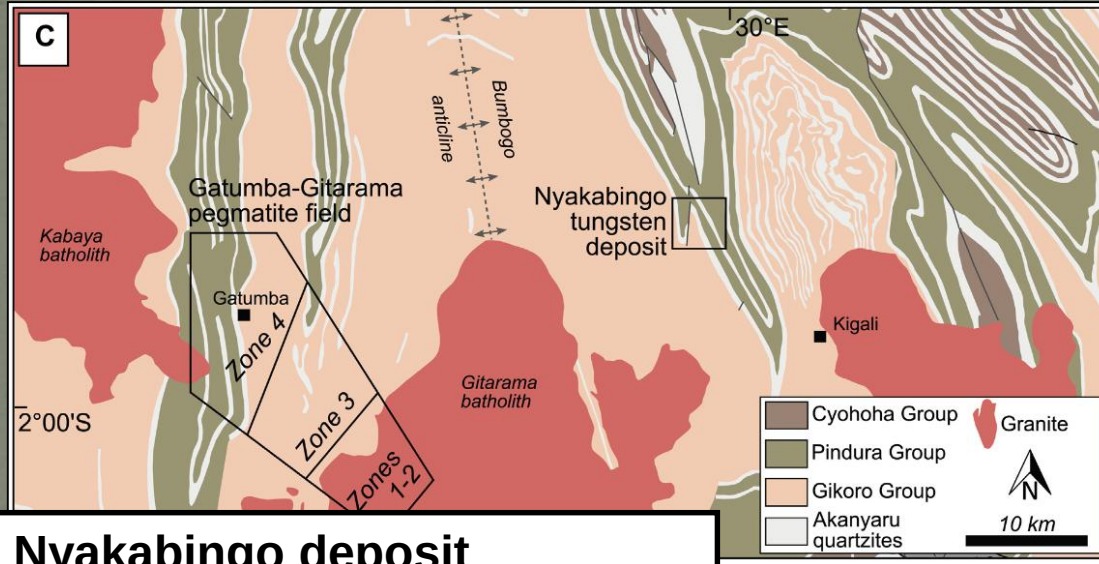
CEROTUNGSTITE, A CERIUM ANALOGUE TO YTTROTUNGSTITE, FROM UGANDA

TH. G. SAHAMA¹, OLEG V. KNORRING² and MARTTI LEHTINEN¹

Sahama *et al.* (1970)

Discovery of yttrotungstite-(Nd)

© Hulsbosch *et al.* (2016)



- Nyakabingo deposit
- 10 km NNW of Kigali, Rwanda
- Tungsten Belt

- Oxidation mineral
- Yellow-orange tabular crystals, frequently forming radiated groups
- Associated with anthoinite and hydrokenoelsmoreite



New mineral species (IMA 2023-064, Ytgs-Nd)



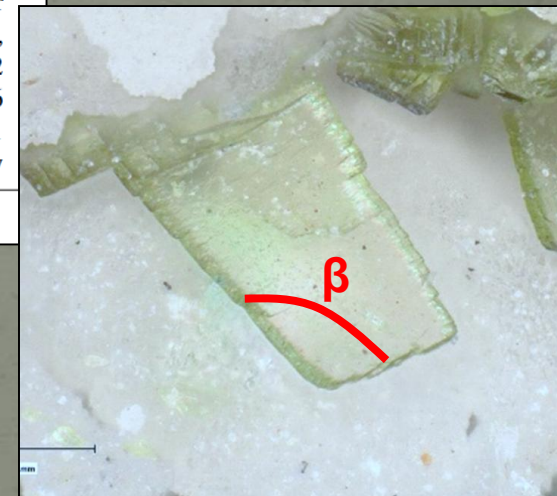
Chemical analyses and physical properties

Constituent	Mean	Range	SD (σ)
WO ₃	73.40	71.58–74.79	0.96
MoO ₃	0.07	0.00–0.26	0.08
P ₂ O ₅	0.18	0.08–0.27	0.05
As ₂ O ₅	0.04	0.00–0.14	0.05
SiO ₂	0.02	0.00–0.05	0.02
TiO ₂	0.03	0.00–0.09	0.03
Al ₂ O ₃	0.01	0.00–0.02	0.01
CaO	0.09	0.01–0.28	0.07
K ₂ O	0.01	0.00–0.05	0.01
Y ₂ O ₃	0.91	0.36–1.45	0.37
Ce ₂ O ₃	3.17	2.35–4.49	0.65
La ₂ O ₃	1.44	0.68–2.77	0.72
Pr ₂ O ₃	2.10	1.61–2.64	0.30
Nd ₂ O ₃	9.37	8.90–9.66	0.19
Sm ₂ O ₃	3.56	2.39–4.24	0.55
Eu ₂ O ₃	0.07	0.00–0.36	0.12
Gd ₂ O ₃	1.74	1.04–2.28	0.34
Tb ₂ O ₃	0.07	0.00–0.33	0.09
Dy ₂ O ₃	0.81	0.57–1.30	0.22
Er ₂ O ₃	0.09	0.00–0.25	0.07
Yb ₂ O ₃	0.71	0.46–0.90	0.12
H ₂ O ^d _{calc.}	4.24	–	–
Total	102.13		

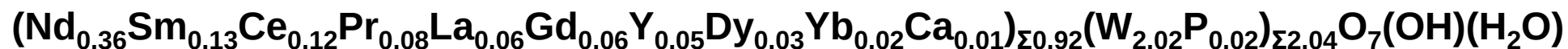
Mineral	Yttrotungstite-(Nd)	Yttrotungstite-(Ce) ¹	Yttrotungstite-(Y) ²
Reference	This work		
Ideal formula	NdW ₂ O ₇ (OH)(H ₂ O)	CeW ₂ O ₇ (OH)(H ₂ O)	YW ₂ O ₇ (OH)(H ₂ O)
Space group	<i>P</i> 2 ₁ / <i>m</i>	<i>P</i> 2 ₁ / <i>m</i>	<i>P</i> 2 ₁ / <i>m</i>
<i>a</i> (Å)	5.8534(3)	5.874(5)	5.77
<i>b</i> (Å)	8.6881(3)	8.700(5)	8.64
<i>c</i> (Å)	7.0488(4)	7.070(5)	6.95
β (°)	105.336(5)	105.45(5)	104.93
<i>Z</i>	2	2	2
Cleavage	(010) perfect, (100) and (001) excellent	(100) perfect	(010) perfect, (10-1) poor
Refraction indices	$\alpha = 1.90(2)$, $\gamma = 2.10$	$\alpha = 1.89$, $\beta = 1.95$, $\gamma = 2.02$	$\alpha = 1.89$, $\beta = 1.98$, $\gamma = 2.02$
Density	6.25 (calc.)	5.82	5.96
Hardness	1	~ 1	~ 1
Colour	Yellow-orange	Orange-yellow	Orange-yellow

¹ Sahama et al. (1970), ² Davis and Smith (1971).

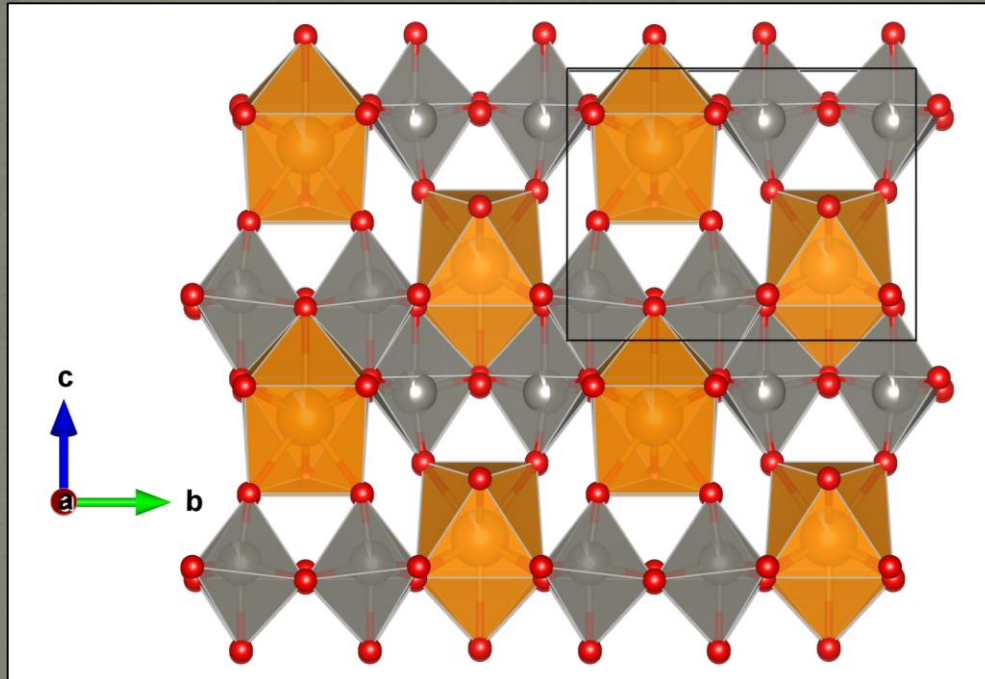
- $\beta \sim 105^\circ$
- Platy crystals oriented parallel to the (010) plane



Empirical chemical formula

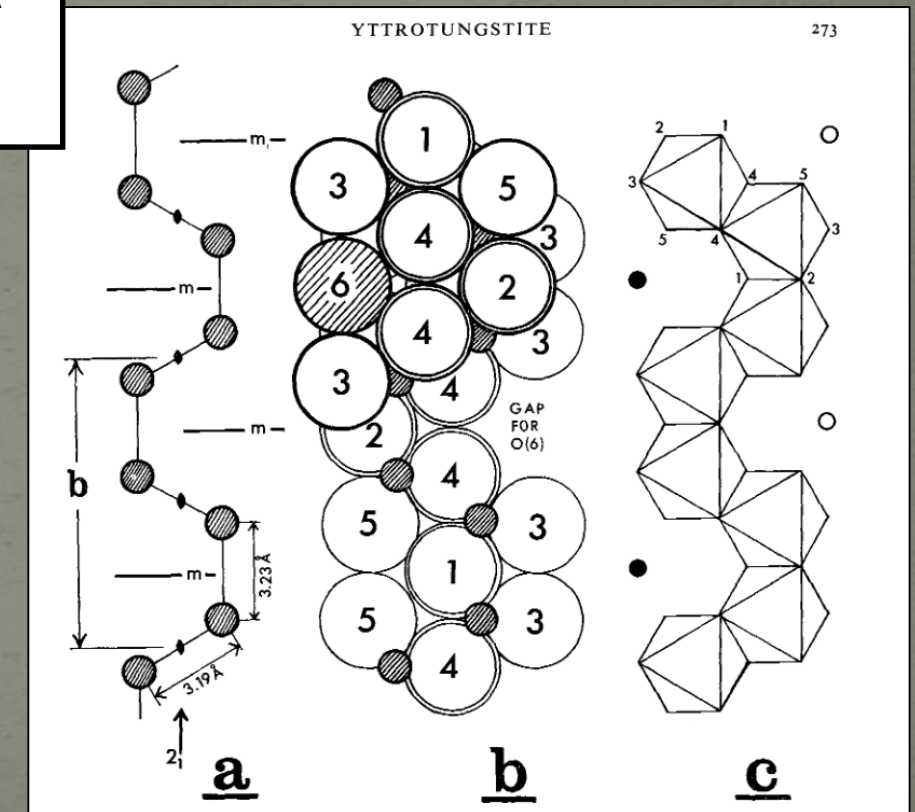


Crystal structure determination



S.G. $P2_1/m$
 $a = 5.8534(3) \text{ \AA}$
 $b = 8.6681(3) \text{ \AA}$
 $c = 7.0488(4) \text{ \AA}$
 $\beta = 105.336(5)^\circ$
 $R_1 = 3.62 \%$

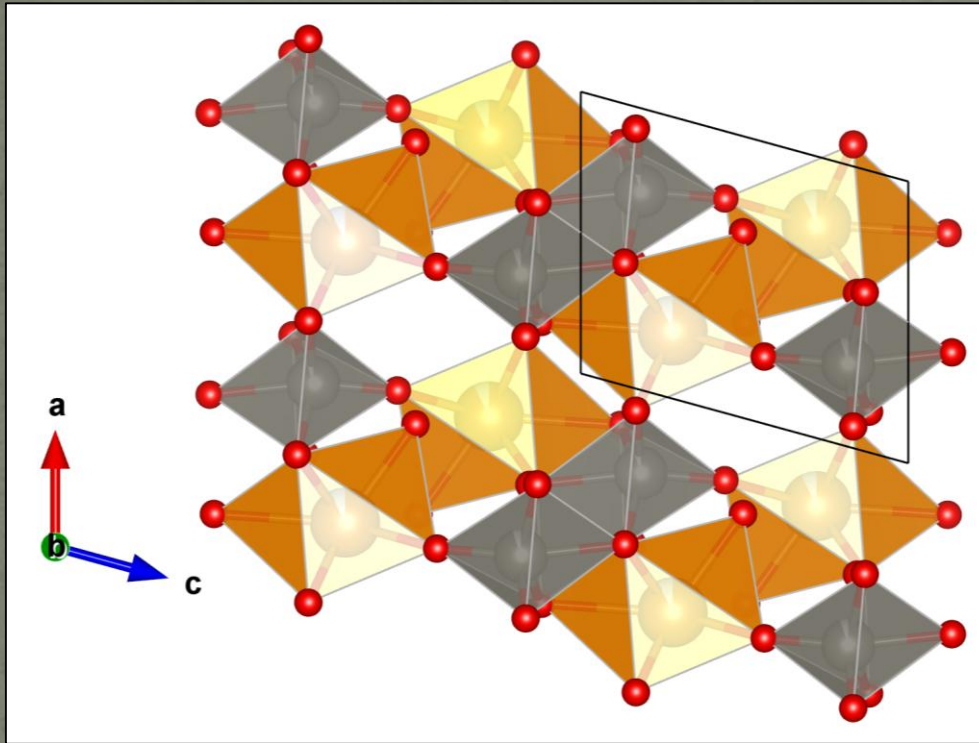
- WO_6 edge-sharing octahedra
- Kinked chains along the b axis
- NdO_8 polyhedra connect those chains



Davis & Smith (1971)

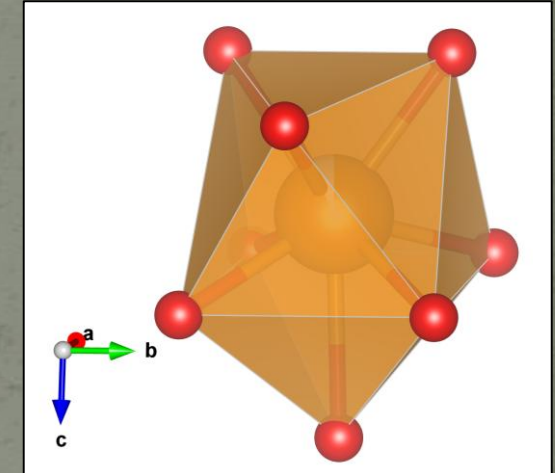
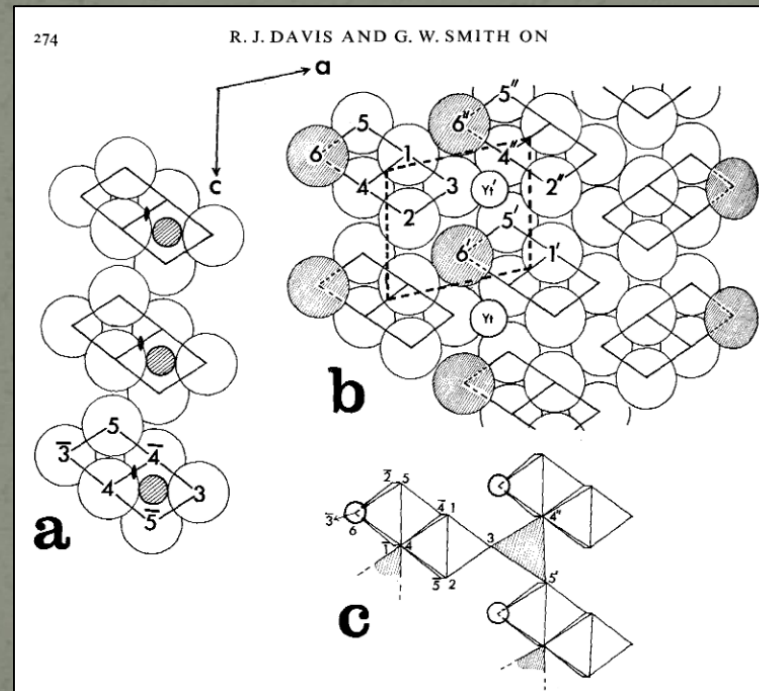
➔ Similar to the model of Davis & Smith (1971)

Crystal structure determination



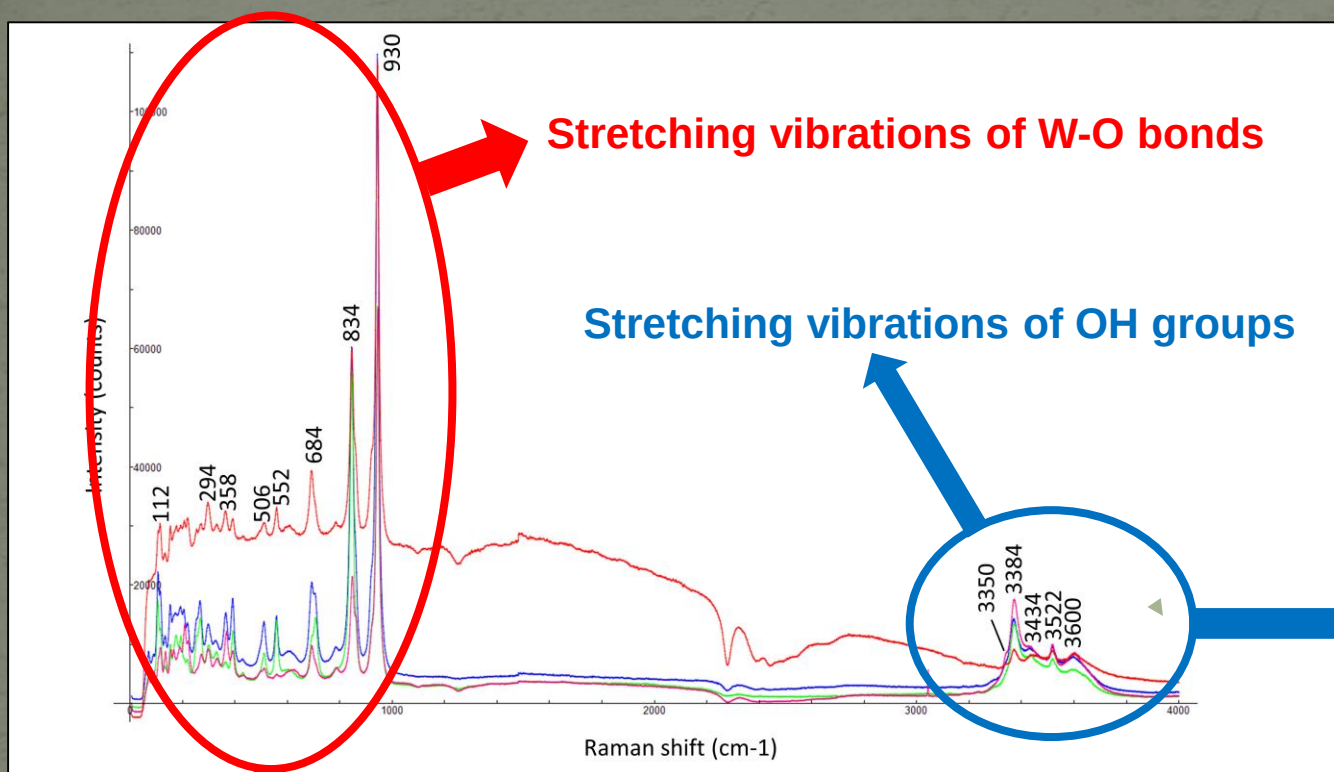
- NdO_8 and WO_6 polyhedra occur in two types of planes
- Stacked parallel to the $[-101]$ plane

Davis & Smith (1971)



- Nd occurs in a very large 8-fold polyhedron
- Two tetragonal pyramids sharing one basal edge and sharing the opposite basal edges with a square

Raman spectral results



	Observed O-H...O distance	Calculated wavelengths*	Observed wavelengths
OH5-O4	2.481(16)	1472	
OW6-OH5	2.68(2)	3122	
OH5-O1	2.727(12)	3263	3350,
OH5-O2	2.745(7)	3305	3384
OH5-O2'	2.824(14)	3434	3434
OW6-O1	2.974(14)	3541	
OW6-O2	3.004(14)	3552	3522
OW6-O1'	3.041(8)	3561	
OW6-O3	3.449(17)	3591	3600

* Calculated wavelengths were obtained from the empirical correlation established by Libowitzky (1999).

W1-O1	1.765(9)	Nd2-O1 x2	2.429(8)
W1-O2	2.161(9)	Nd2-O2 x2	2.359(7)
W1-O2'	1.881(7)	Nd2-O3 x2	2.378(7)
W1-O3	1.764(7)	Nd2-O4	2.727(12)
W1-OH5	2.204(6)	Nd2-OW6	2.511(12)
W1-O4	1.961(5)	Mean	2.446
Mean	1.955		

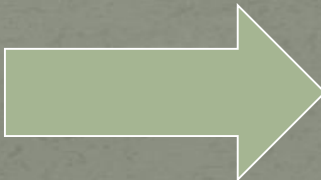
- **930 cm⁻¹ = W1-O1 and W1-O3 (calc. 900-901 cm⁻¹)**
- **834 cm⁻¹ = W1-O2' (calc. 722 cm⁻¹)**
- **684 cm⁻¹ = W1-O4 (calc. 620 cm⁻¹)**

Calculations according to Hardcastle & Wachs (1995)

The role of water and OH groups

Bond-valence calculations

	W1	Nd2	Sum
O1	1.570	$0.415 \times 2 \downarrow$	1.99
O2	0.476	$0.502 \times 2 \downarrow$	2.06
O2'	1.086		
O3	1.534	$0.477 \times 2 \downarrow$	2.01
O4	$0.858 \times 2 \rightarrow$	0.186	1.90
OH5	$0.419 \times 2 \rightarrow$		0.84
OW6		0.333	0.33
Sum	5.94	3.31	

- 
- Four oxygen atoms (O1, O2, O3, O4)
 - One (OH) group (OH5)
 - One water molecule (OW6)

- 
- Formula of yttrotungstite-(Nd) = $\text{NdW}_2\text{O}_7(\text{OH})(\text{H}_2\text{O})$
 - Different from that of yttrotungstite-(Ce) = $\text{CeW}_2\text{O}_6(\text{OH})_3$

Bond-valence calculations from the structural model of Davis & Smith (1971) for yttrotungstite-(Y)

- 
- BVS = 1.13 for O1
 - BVS = 0.31 for Wat6



One water molecule also occurs in the structure of yttrotungstite-(Y)

Uniformization of the yttrotungstite group



IMA-CNMNC list



IMA Commission on New Minerals, Nomenclature and Classification (CNMNC) – Newsletter 91

Ferdinando Bosi^{1,*}, Frédéric Hatert^{2,**}, Marco Pasero^{3,**}, and Stuart J. Mills^{4,***}

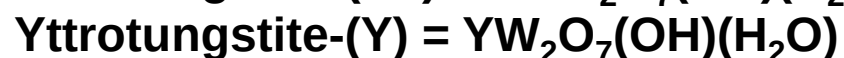
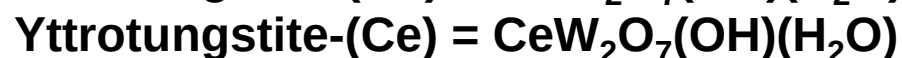
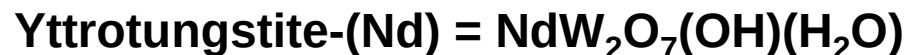
4 Other issues

Polish-up of the IMA List of Minerals (second round)

After a similar action made some years ago (see CNMNC Newsletter 50), the IMA-CNMNC is making effective a number of minor changes in the ideal chemical formulae of mineral species. In most cases the change merely consists of the elimination of subordinate constituents occurring within the same parentheses together with the dominant

Eur. J. Mineral., 38, 347–352, 2026

New end-member formulae



Yttrotungstite-(Y)

Current formula: $\text{Y(W,Fe,Si,Al,Ti)}_2(\text{O,OH,H}_2\text{O})_9$

New formula: $\text{YW}_2\text{O}_7(\text{OH})(\text{H}_2\text{O})$

[Cf. yttrotungstite-(Nd): $\text{NdW}_2\text{O}_7(\text{OH})(\text{H}_2\text{O})$]

Yttrotungstite-(Ce)

Current formula: $\text{CeW}_2\text{O}_6(\text{OH})_3$

New formula: $\text{CeW}_2\text{O}_7(\text{OH})(\text{H}_2\text{O})$

[Cf. yttrotungstite-(Nd): $\text{NdW}_2\text{O}_7(\text{OH})(\text{H}_2\text{O})$]

Conclusions

- Yttrotungstite-group minerals occur in tungsten deposits, for example in the Tungsten Belt, Rwanda.
- They constitute secondary phases produced by hydrothermal alteration of ferberite pseudomorphs (« reinite »).
- The discovery of the new mineral species yttrotungstite-(Nd), in the Nyakabingo deposit, allowed to determine a reliable structural model for these minerals.
- Starting from this model, bond-valence calculations indicate the presence of one water molecule in the structure, thus implying a modification of the chemical formulae of the whole group, including those of yttrotungstite-(Ce) and of yttrotungstite-(Y).