Carlsonite $(NH_4)_5Fe^{3+}{}_3O(SO_4)_6 \cdot 7H_2O$

Crystal Data: Triclinic. *Point Group*: $\bar{1}$. Crystals display {100}, {001}, {1$\bar{1}$ 0}, (1$\bar{1}$ $\bar{1}$ }, {01$\bar{2}$ } and {111}, are flattened on {001}, or form stout prisms, elongated along [110], to ~ 0.5 mm. *Twinning*: Cross-hatched twins in transmitted light and crossed polars.

Physical Properties: *Cleavage*: Perfect on {001}. *Fracture*: Irregular. *Tenacity*: Brittle. Hardness = 2 D(meas.) = n.d. D(calc.) = 2.167 Soluble in water.

Optical Properties: Transparent. *Color*: Yellow to orange-brown. *Streak*: Tan. *Luster*: Vitreous.
Optical Class: Biaxial (–). α = 1.576(1) β = 1.585(1) γ = 1.591(1)
2V(meas.) = 80(1)° 2V(calc.) = 78° *Dispersion*: Strong; $r > v$. *Orientation:* $X \approx \perp$ {001}; $Z \approx$ [110]. Pleochroism: X= yellow; $Y = Z$ = orange. *Absorption*: $X < Y \approx Z$.

Cell Data: Space Group: $P\bar{1}$. a = 9.5927(2) b = 9.7679(3) c = 18.3995(13) α = 93.250(7)° β = 95.258(7)° γ = 117.993(8)° Z = 2

X-ray Powder Pattern: Huron River burn site, Ohio, USA.
9.23 (100), 7.57 (43), 3.144 (41), 8.26 (40), 4.93 (23), 3.328 (20), 3.035 (16)

Chemistry:	(1)	(2)	(3)
$(NH_4)_2O$	[12.75]	12.30	13.34
Na_2O	0.79	0.76	
K_2O	0.59	0.57	
Fe_2O_3	25.70	24.79	24.54
SO_3	50.67	48.88	49.21
H_2O	[13.16]	12.70	12.92
Total	103.66	100.00	100.00

(1) Huron River burn site, Ohio, USA; average of 7 electron microprobe analyses supplemented by Raman and IR spectroscopy, $(NH_4)_2O$ and H_2O calculated from structure analysis. (2) Analysis (1) normalized; corresponding to $[(NH_4)_{4.64}Na_{0.24}K_{0.12}]_{\Sigma=5.00}Fe^{3+}{}_{3.05}O(SO_4)_6 \cdot 6.93H_2O$.
(3) $(NH_4)_5Fe^{3+}{}_3O(SO_4)_6 \cdot 7H_2O$.

Occurrence: Formed by a natural fire in oil-bearing shale exposed along a cliff.

Association: Anhydrite, boussingaultite, gypsum, lonecreekite.

Distribution: From a cliff (the Huron River burn site 2009-2011) along the Huron River, ~ 6.1 km WSW of Milan, Ohio, USA.

Name: Honors Ernest H. Carlson (1933-2010), Professor of Mineralogy, Kent State University, Ohio, USA and author of Ohio Geological Survey Bulletin 69, *Minerals of Ohio* (1991).

Type Material: Natural History Museum of Los Angeles County, Los Angeles, California, USA (65544 and 65545).

References: (1) Kampf, A.R., R.P. Richards, B.P. Nash, J.B. Murowchick, and J.F. Rakovan (2016) Carlsonite, $(NH_4)_5Fe^{3+}{}_3O(SO_4)_6 \cdot 7H_2O$, and huizingite-(Al), $(NH_4)_9Al_3(SO_4)_8(OH)_2 \cdot 4H_2O$, two new minerals from a natural fire in an oil-bearing shale near Milan, Ohio**.** Amer. Mineral., 101, 2095-2107.