Carminite $PbFe_2^{3+}(AsO_4)_2(OH)_2$

Crystal Data: Orthorhombic. *Point Group:* $2/m\ 2/m\ 2/m$. Crystals, to 2 cm, typically lathlike, flattened on {010}, elongated along [001], showing {010}, {110}, {011}, and other forms; as needlelike crystals, in spherical or tufted aggregates; fibrous, drusy, massive.

Physical Properties: *Cleavage:* On {110}, distinct. *Tenacity:* Brittle. Hardness = 3.5 D(meas.) = 5.03–5.18; 5.22 D(calc.) = 5.405

Optical Properties: Translucent. *Color:* Carmine, tile-red, reddish brown; red in transmitted light. *Streak:* Reddish yellow. *Luster:* Vitreous, pearly on cleavages.
Optical Class: Biaxial (+). *Pleochroism:* X = pale yellowish red; $Y = Z$ = dark carmine. *Orientation:* $X = c$; $Y = a$; $Z = b$. *Dispersion:* $r < v$, strong. *Absorption:* $Y = Z > X$.
α = 2.05–2.07 β = 2.05–2.07 γ = 2.06–2.08 2V(meas.) = Medium.

Cell Data: *Space Group: Cccm.* $a = 16.591(2)$ $b = 7.580(1)$ $c = 12.285(1)$ Z = 8

X-ray Powder Pattern: Mapimí, Mexico.
3.20 (10), 2.580 (9), 2.929 (8), 1.799 (8), 3.50 (7), 2.705 (7), 2.154 (7)

Chemistry:	(1)	(2)	(3)		(1)	(2)	(3)
As_2O_5	33.98	35.77	36.44	MgO	0.06		
Al_2O_3	0.96	0.17		CaO	0.44		
Fe_2O_3	23.43	23.54	25.33	H_2O^+	2.9		
FeO	0.21			H_2O^-	0.10		
CoO		0.12		H_2O		[2.85]	2.85
CuO		0.18		insol.	0.58		
PbO	37.30	36.98	35.38	Total	99.96	[99.61]	100.00

(1) Ojuela mine, Mapimí, Mexico; estimated impurity cerussite 5%. (2) Pira Inferida mine, Sardinia, Italy; by electron microprobe, total Fe as Fe_2O_3, H_2O from theoretical composition; corresponds to $(Pb_{1.06}Co_{0.01}Cu_{0.01})_{\Sigma=1.08}(Fe_{1.90}Al_{0.02})_{\Sigma=1.92}(AsO_4)_{2.00}(OH)_{2.03}$.
(3) $PbFe_2(AsO_4)_2(OH)_2$.

Polymorphism & Series: Dimorphous with mawbyite.

Occurrence: An uncommon alteration product of arsenopyrite in some oxidized lead-bearing mineral deposits.

Association: Beudantite, scorodite, dussertite, arseniosiderite, bayldonite, mimetite, cerussite, anglesite, plumbojarosite, wulfenite.

Distribution: In Germany, from the Louise iron mine, near Horhausen, and in the Schöne Aussicht mine, near Dernbach, Westerwald; at the Merkur mine, Ems, Rhineland-Palatinate. In England, from Caldbeck Fells, and in the Wanthwaite mine, St. John's in the Vale, Cumbria; at the Hingston Downs Consols mine, Calstock; from Penberthy Croft, Wheal Gorland, and other mines in Cornwall. At the Cap Garonne mine, near le Pradet, Var, France. In the USA, at Eureka, Ruby Hill district, Eureka Co., and in the Killie mine, Spruce Mountain district, Elko Co., Nevada; from the Centennial Eureka mine, Tintic district, Juab Co., and at the Gold Hill mine, Tooele Co., Utah. In Mexico, from the Ojuela mine, Mapimí, Durango, in large crystals; at Santa Ana, La Mur, and at the San Félix mine, Caborca, Sonora. From Broken Hill, New South Wales, at Wyloo, and in the Anticline prospect, 11 km west-southwest of Ashburton Downs homestead, Capricorn Range, Western Australia. As large crystals at Tsumeb, Namibia. Other minor localities are known.

Name: For the characteristic *carmine* color.

References: (1) Palache, C., H. Berman, and C. Frondel (1951) Dana's system of mineralogy, (7th edition), v. II, 912–913. (2) Rosenzweig, A. and J.J. Finney (1959) The unit cell of carminite. Amer. Mineral., 44, 663–665. (3) Olmi, F. and C. Sabelli (1995) Carminite from three localities of Sardinia (Italy). Crystal structure refinements. Neues Jahrb. Mineral., Monatsh., 553–562. (4) Kharisun, M.R. Taylor, D.J.M. Bevan, and A. Pring (1996) The crystal structure of carminite: refinement and bond valence calculations. Mineral. Mag., 60, 805–811.